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TITLE: AN ENERGY-CONSERVATION STUDY FOR THE US AIR FORCE ACADEMY

AUTHORIS: John L. Peterson and L. Brooke Davis

SUBMITTED TO 10 be presented at the US Air Force Academy Energy Management Personnel Meeting, Colorado Springs, Colorado, March 1983.

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AN ENERGY CONSERVATION STUDY

FOR

THE US AIR FORCE ACADEMY

Prepared by

John L. Peterson and !. Brooke Davis Solar Energy Group (Q-11), MS K571 Los Alamos National Laboratory Los Alamos, NM 87545 Telephone: (505) 667-9036

To be presented at the US Air Force Academy Energy Management Personnel Meeting Colorado Springs, Colorado March 1983

CONTENTS

I.	INTRODUCTION	1
11.	METHODOLOGY	2
III.	BUILDING DESCRIPTIONS	2
IV.		
٧.	CONCLUSIONS	5
APPEN	DIX A: PERFORMANCE CALCULATIONS	
	II. SPECIFICS CONCERNING INPUT DATA A. Vandenberg Hall 1. LOADS input 2. SYSTEMS input 3. PLANT input B. Field House 1. LOADS input 2. SYSTEMS input 3. PLANT input C. Aeronautics Laboratory 1. LOADS input 2. SYSTEMS input 2. SYSTEMS input 3. PLANT input C. Aeronautics Laboratory 1. LOADS input 2. SYSTEMS input 2. SYSTEMS input 3. PLANT input 2. SYSTEMS input 3. PLANT input	7793333556
	III. SUMMARY OF PERFORMANCE RESULTS - VANDENBERG HALL	3
	IV. SUMMARY OF PERFORMANCE RESULTS - FIELD HOUSE	32
	V. SUMMARY OF PERFORMANCE RESULTS - AERONAUTICS LABORATORY	36
	VI. BASELINE COMPUTER MODEL LISTINGS	12

CONTENTS (Cont.)

APPENDIX B	B: ECONOMIC ANALYSIS	32 32 33
II.	SUMMARY OF THE ECONOMIC RESULTS	35
III.	. DOCUMENTATION OF ECONOMICS ANALYSIS	35

AN ENERGY CONSERVATION STUDY FOR THE US AIR FORCE ACADEMY*

bу

John L. Peterson and L. Brooke Davis

Solar Energy Group (Q-11), MS K571 Los Alamos National Laboratory Los Alamos, NM 87545

ABSTRACT

The United States Air Force Academy (AFA) has asked the Los Alamos National Laboratory to assist them in conducting detailed energy and solar analyses of selected AFA buildings using the DOE-2 building energy analysis computer program. This report presents the results of the energy conservation study conducted by Los Alamos in FY 1981 and 1982 for Building 2360 (Vandenberg Hall), Building 2169 (Field House), and Building 2410 (Aeronautics Laboratory).

Energy Conservation and Solar Opportunities (ECOs) are identified for each building and predicted heating, cooling and electric energy savings are presented for each ECO. Economic results are summarized as annual dollars saved, discounted benefit-to-cost ratio, maximum investment targets, and the life-cycle cost of implementing each ECO.

I. INTRODUCTION

The United States Air Force Academy (AFA) at Colorado Springs, Colorado, has for several years been implementing an intensive energy management program for its facilities.

An energy conservation study has been conducted by the Los Alamos National Laboratory for the United States Air Force on three buildings located at the Air Force Academy: Building 2360 (Vandenberg Hall), Building 2169 (Field House), and Building 2410 (Aeronautics Laboratory). The approach included a survey of each building to evaluate the energy use of each by performing a comprehensive energy analysis using the DOE-2 computer program. The intent of this study was to identify energy conservation opportunities (ECOs)

^{*}This work was performed under the auspices of the Department of Engineering/ Energy Management, United States Air Force Academy.

that were cost effective in terms of Department of Defense (DOD) economic criteria for Energy Conservation Investment Program (ECIP) projects. The results of this study are presented in a series of recommendations in this report.

II. METHODOLOGY

The energy surveys were based on a detailed review of as-built drawings, on-site verification, and on-site discussions with building managers and operating personnel. Data were collected regarding the number of people occupying the buildings, operating schedules, and the energy loads imposed by equipment and lights. Heating, ventilating, and air-conditioning (HVAC) and physical plant equipment and operating practices were also investigated.

Input for the DOE-2.1A computer model of these buildings was based on the results of these surveys. Preliminary ECOs were developed, computer simulations were performed, and the results for each ECO were compared against those obtained from a simulation of the existing building (base line energy consumption). Those ECOs showing the greatest performance improvement at the least potential cost were subjected to a final computer analysis evaluating the effect of combining promising ECOs. The energy savings reported within the Recommendations, Sec. IV, reflect the incremental energy saved when combining alternative ECOs.

The basis for funding requests by the Air Force Academy for each ECO was established by the ECIP criteria that

- 1. all projects amortize within their economic life, and
- 2. all projects produce an energy-to-cost ratio (E/C) of at least 15. In our judgment, the cost of implementing each recommended ECO will be less than the funds requested. Appendix A presents a detailed discussion of the performance analysis of each building; a detailed economic analysis can be found in Appendix B.

III. BUILDING DESCRIPTIONS

Vandenberg Hall is a 760,000 ft² complex billeting 2,400 Air Force cadets and providing laundry, storage, recreational, assembly, and shopping facilities to the residents. The building is characterized by energy conserving architectural features such as insulated curtain walls, 10-in. concrete floors and roofs with exterior insulation, and heat-absorbing, double-glazed,

operable windows. Like many other buildings of the Academy, Vandenberg Hall is supplied with hot water from a central boiler utility through an underground tunnel distribution system. The high-temperature water from the utility is converted within the building to medium— and low-temperature sources of water serving the HVAC and domestic hot water (DHW) systems, respectively. With the exception of certain specialty areas within the building, air temperatures are maintained at 65°F during the day and 55°F at night in the winter by hot water baseboard heaters. In the summer, the tempering effect of manually operated drapes and windows couple with the massive concrete structure to passively control the temperature swings within the living quarters. A once—through ventilation system is used to maintain air quality within the building throughout the year.

The Field House is a two-story 246,000 ft² high-bay building that encloses a basketball stadium, an ice hockey arena, and a multipurpose/track facility. Like Vandenberg Hall, this building is supplied with hot water from a central boiler utility and underground tunnel distribution system to heat the building. Mechanical chilling is provided to produce ice for the ice hockey rink. The building is serviced by several large air-handling units in each of the above three areas. These units function in a 100% recirculation mode to maintain the building at 68°F. During sports events, concerts, or other activities in which there are a large number of people in the building, the units operate in a 100% ventilation mode in which outside air is brought into the building to meet the increased interior load. Space cooling is accomplished entirely through the use of mechanical ventilation.

The Aeronautics Laboratory (Aero Lab) is a two-story building functionally divided into classrooms, laboratories, offices, and test cells. The building is an architecturally massive structure with an advantageous solar orientation along a long east-west axis. However, the building has limited potential as a solar heating retrofit project because of the large internal loads generated within the structure. The flat roof is constructed of built-up roofing on a 2-in. poured gypsum foundation. The exterior walls on the upper floor are precast concrete panels covering a cinder block structure whereas the lower floor walls are a combination of concrete block and poured concrete with the north and west walls completely underground. The Aero Lab receives high-temperature hot water from the central boiler utility and converts the water to medium-temperature water for use in the building HVAC

system. Chilled water for space cooling is received from absorption chillers located in the basement of Fairchild Hall, which is adjacent to the Aero Lab. A central multizone system serves the entire upper floor area and most of the lower floor. With the exception of the mechanical room and the test cells, air temperature is maintained at 68°F during the day and 60°F at night. A four-pipe fan coil system is used to heat and cool the test-cell classrooms. Unit heaters are used to heat those areas not conditioned by the multizone or four-pipe fan coil systems; a thermostatically controlled ventilation fan cools the mechanical room.

IV. RECOMMENDATIONS

A. Building 2360, Vandenberg Hall

There are four recommendations for Vandenberg Hall that meet the FY-1984 ECIP guidance for cost effectiveness: ventilation air reductions, heat recovery, motor and fan efficiency improvements, and reinstatement of economizer operation. Each is described below and the existing equipment that will be affected by these recommendations is identified.

1. Reduce Building Ventilation Rates. Vandenberg Hall was designed in 1956 to meet all building codes in effect at that time; however, since 1956, a significant amount of research has been conducted to determine the effect of ventilation air on the health of building occupants. This research has led to the lowering of minimum fresh air requirements for buildings in keeping with more energy efficient design practice. The American Society of Heating. Refrigerating, and Air-Conditioning Engineers (ASHRAE) summarizes the recommendations of their Society concerning the results of this research in the nationally accepted ASHRAE Standard 62-73, "Standards for Natural and Mechanical Ventilation." It is proposed that the operation of the ventilation equipment supporting Vandenberg Hall be modified in accordance with this standard. The ventilation equipment that would be affected by this modification includes the heating and ventilating units supplying fresh air to the building corridors (corridor fans) and the fans (toilet and storage area fans) exhausting air from the shower, toilet, and storage areas of the building. The equipment numbers are shown in Tables I and II under the heading, "Supporting Ventilation Equipment."

ASHRAE Standard 62-73 recommends that a minimum of 10 cfm and 15 cfm of fresh air be supplied to each person occupying the shower and toilet areas of a military installation, respectively. Assuming that all of the occupants of the cadet facilities be located in these areas at any one time, the minimum ventilation rate can be calculated as follows:

2400 people x
$$\frac{(10 + 15)}{2}$$
 cfm/person = 30,000 cfm.

The corridor fans are installed to deliver 56,000 cfm of fresh air to these areas continuously, as well as 32,900 cfm to the storage areas of the building through use of the building corridors as supply air plenums. Toilet fans are installed to exhaust 56,000 cfm of air from the shower and toilet areas continuously. We recommend that delivery of 88,900 cfm through these corridors be reduced and that the air exhausted from the shower and toilet areas be reduced to 30,000 cfm. The exhaust air reduction should be accomplished, as indicated in Table I, to maintain the building air balance. Reducing the air exhausted from each individual shower and toilet area in proportion to the total recommended reduction will provide the ventilation rates shown in Table I.

Reductions in ventilation air continuously supplied to the storage areas of Vandenberg Hall are also recommended. ASHRAE Standard 62-73 recommends a minimum ventilation rate of 5 cfm per person in storage areas. Assuming that only one person occupies every 200 ft² of storage floor area during duty hours, the rate of fresh air recommended for each storage area is shown in Table II. The storage fans supporting these areas should exhaust air at the rates indicated in Table II. Note that the recommended ventilation rate of 1,252 cfm for all of these areas is considerably less than the 32,900 cfm currently exhausted. Because the supply of fresh air to the storage areas is also provided by the corridor fans, a total reduction from the 88,900 cfm currently supplied to 31,252 cfm is recommended to maintain the building air balance.

Other areas of Vandenberg Hall were investigated for potential reductions in the rate of fresh air delivery. The truck dork, fireplace, lyceum, forge, and paint spray booth are ventilated by fans that are infrequently used, so they were excluded as potential candidates. Likewise, the electrical

TABLE I
SHOWER AND TOILET VENTILATION RECOMMENDATIONS

Building Location	Design Ventilation Air (cfm)	Recommended Ventilation Air (cfm)	Supporting ^(a) Ventilation Equipment
First Floor, Unit 3	1,560	836	HV 3 and 4; EX-19
Second Floor, Unit 1	5,880	3,150	HV 42, 43, 54, 55; EX-1 thru 4, 6 and 7, 9 thru 16
Second Floor, Unit 2	3,920	2,100	A
Second Floor, Unit 3	3,740	2,004	
Third Floor, Unit 1	5,880	3,150	
Third Floor, Unit 2	3,920	2,100	
Third Floor, Unit 3	3,740	2,004	•
Fifth Floor, Unit 1	5,860	3,139	HV 44, thru 53 EX-1 thru 4, 6 and 7, 9 thru 16
Fifth Floor, Unit 2	3,900	2,089	A
Fifth Floor, Unit 3	3,920	2,100	
Sixth Floor, Unit 1	5,860	3,139	
Sixth Floor, Unit 2	3,900	2,089	
Sixth Floor, Unit 3	3,920	2,100	
Total	56,000	30,000	▼

aRefer to equipment numbers on building drawings.

TABLE II
STORAGE VENTILATION RECOMMENDATIONS

Building Location	Floor Area (ft ²)	Recommended Ventilation Air (cfm)	Supporting ^a Ventilation Equipment
First Floor, Unit 3	17,064	427	HV 3, 4; EX-19
Second Floor, Unit 1	6,440	161	HV 42, 43. 54, 55; EX-20
Second Floor, Unit 2	5,840	146	HV 42, 43, 54, 55; EX-21
Second Floor, Unit 3	7,200	180	HV 42, 43 54, 55; EX-22
Third Floor, Unit 1	6,440	161	HV 42, 43, 54, 55; EX-20
Third Floor, Unit 2	5,840	146	HV 42, 43, 54, 55; EX-21
Third Floor, Unit 3	1,232	31	HV 42, 43, 54, 55; EX-22
Total	50,056	1,252	

^aRefer to equipment numbers on building drawings.

substation and utility tunnel areas are unconditioned spaces, so modifications to the fans ventilating these areas would not realize significant energy savings. All of the remaining areas require only 19,560 cfm of fresh air delivery by other ventilating fans, so they were dismissed as marginal candidates.

The implementation of this recommendation is calculated with DOE-2.1A to save 13,287 x 10^6 Btu of primary energy annually at the source.

2. Waste Heat Recovery. The potential for reclaiming waste heat currently exhausted to the environment is large for Vandenberg Hall. Conservatively assuming that Recommendation 1 is adopted, even after significant

reductions in ventilation air rates, some 50,812 ft³ of heated air will be exhausted each minute from this building. This equates to a consumption of

1.08 x
$$\frac{50.812 \text{ cfm}}{1.3 \text{ x } 0.7}$$
 x 8023 F-day x $\frac{24 \text{ h}}{\text{day}}$ = 11,6.2 x 10^{6*} Btu

of fuel annually at the central boiler plant. Thus, we recommend that either one of two approaches or a combination of both approaches be used to reclaim waste heat: waste heat recovery from the ventilation air exhaust, and/or heat recovery from the utility tunnel system.

The recovery of heat from air exhausted from the building can be accomplished by constructing a closed run-around heat recovery loop with heat exchange coils located in the supply and return ventilation system ductwork. Heat recovered from the exhaust air would be used to preheat the building's outlide air supply. We proposed such a system for the Sigma Building at Los Alamos National Laboratory and a copy of the conceptual scheme is shown in Fig. 1. The equipment affected would be the same as shown in Table I and Table II plus fans HV-1, 2, 6, 7, 8, and EX-5, 8, 17, 26, 32, 33, and 24.

The second heat recovery option would involve reclaiming waste heat from the utility tunnels serving the Air Force Academy. We estimate that 300 Btu/h of heat can be recovered for each linear foot of utility tunnel. This assumes that two (supply and return) 6-in.-diam pipes with 1 1/2-in. of insulation transmit 350°F water through the tunnels. Thus, it would require nearly 3100 linear feet of tunnel to offset the ventilation heat losses of this building. This is determined as follows:

$$\left(11,612 \times 10^6 \frac{\text{Btu}}{\text{yr}} \times 0.7\right) / \left(\frac{300 \text{ Btu}}{\text{h-ft}} \times 8760 \frac{\text{h}}{\text{yr}}\right) = 3093 \text{ linear feet.}$$

^{*}In the above calculation, the combined boiler plant and hot water distribution system is assumed to be 70% efficient and the factor 1.3 is used to convert the ventilation rate at 7100 ft elevation to standard air rates at sea level. The degree days shown are for a 70°F base temperature at Colorado Springs, Colorado. The temperature of the air supplied by the ventilation equipment is 70°F.

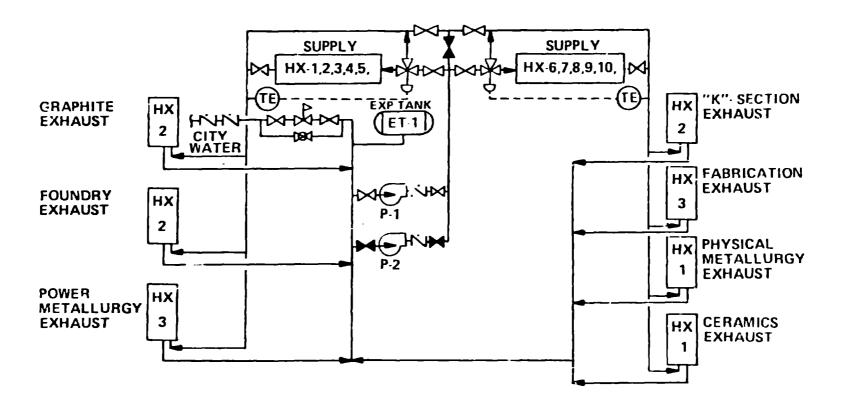


Fig. 1. Heat recovery system for Sigma Building at Los Alamos National Laboratory.

New fans, filters, and distribution ductwork inducing utility tunnel air will have to be installed to deliver the reclaimed waste heat to the ventilation system. The ventilation equipment affected by this modification is the same as specified for the first option for heat recovery.

We suspect that a combination of both heat recovery options will yield the most cost-effective solution. In any event, DOE-2.1A calculations indicate the saving of primary energy (at the source) at $9,477 \times 10^6$ Btu annually. This assumes option 1 is implemented with a heat recovery effectiveness of 75%.

3. Motor and Fan Efficiency Improvements. Many of the fans in Vandenberg are extremely inefficient. For example, the corridor fans HV 45, 49, 50, 52, and 53 are calculated to be 18% efficient as follows:

Fan efficiency =
$$\frac{5800 \text{ cfm} \times 0.5 \text{ in. H}_20}{1.3 \times 6356 \text{ cfm-in.} \times 2.0 \text{ hp}} = 18\%$$

The fan efficiencies of corridor fans range from 18 to 26% and the exhaust fans efficiencies range from 20 to 32%. Furthermore, none of the fans supporting the cadet assembly areas (assembly fans) exceed 18% efficiency. Because corridor, toilet, and storage fans run continuously, a significant opportunity exists to reduce fan power consumption. The assembly fans present a similar, although somewhat reduced, opportunity because they must operate continuously during the winter to maintain thermal comfort and to prevent freezing in the assembly rooms. We recommend that the fans and fan motors supporting these areas be replaced with new fans and motors. The equipment to be replaced should include the assembly fans HV 10 through 39 as well as the equipment defined as being affected by Recommendation 2. Assuming that Recommendations 1 and 2 are implemented and that the specified fan/motor efficiencies can be doubled, DOE-2.1A calculations show the primary energy (at the utility) saving at 4.711 x 10⁶ Btu annually. Larger savings can be realized by fan/motor replacement if the ventilation air reductions recommended previously are not implemented.

4. Reinstatement of Economizer Operation. Maintenance personnel, in the interest of saving energy, have programmed the fresh air dampers of multizone fans S-41 and EX-35 closed when the outdoor temperature drops below 60°F. This is an inappropriate modification of the system that conditions the cadet store area in Vandenberg Hall. The cadet store area is characteristic of a

space that has large internal energy sources. This space requires only a nominal amount of heat, but must be cooled year-round. By programming the fresh air dampers to close when the outdoor temperature drops below 60°F, the system is incapable of providing free ventilation cooling during the winter. All of the cooling must be accomplished by expensive mechanical cooling. We recommend that the economizer cycle originally programmed be reinstated to provide ventilative cooling.

The implementation of this recommendation is calculated by DOE-2.1A to save 350×10^6 Btu annually at the (electric utility) source, assuming that Recommendations 1, 2, and 3 have been previously adopted.

B. Building 2169, Field House

There is only one recommendation for the Field House that meets the FY 1984 ECIP guidance for funding: the pressurization of the building to offset infiltration losses.

An infiltration rate of 0.58* air changes/h is estimated for the Field House. This equates to an infiltration rate of 109,166 cfm for a building volume of 11,293,128 ft³. If the building could be pressurized with 66,000 cfm of 70°F air drawn through the adjacent high-temperature (350°F) hot water utility tunnel such that 60% of the infiltration was eliminated, the consumption of

1.08 x
$$\frac{65,000 \text{ cfm}}{1.3 \text{ x } 0.7}$$
 x 8023°F-day x $\frac{24 \text{ h}}{\text{day}}$ = 15,083 x 10⁶ Btu

of fuel annually at the central boiler plant could be avoided. Thus, we recommend that waste heat recovery from the utility tunnel system be implemented.

The recovery of $10,558 \times 10^6$ Btu (that is, $15,083 \times 10^6 \times 0.7$) of waste heat from the utility tunnel distribution system would require approximately 4000 linear feet of tunnel. This assumes a 350° F water temperature, two 6-in.-diam pipes per utility tunnel, 1-1/2 in. of insulation on the pipes and a maximum of 7.5 mph of air flowing through tunnels. Subsequent to this study, the Air Force Academy completed a retrofit project to install an additional 2 in. of fiber glass insulation on the hot water utility pipes within

^{*}The estimate of infiltration was made after discussions with Joseph Ashley of the US Naval Civil Engineering Research Laboratory. He has been under contract (MIPRN-81-6 with Tyndall AFB) to perform tracer gas infiltration tests of large airplane hangers.

the tunnel adjacent to the Field House. The reduced heat loss available for recovery increases the length of tunnel required to 13,400 linear feet.

The recommended ECO retrofit involves the installation of heat recovery equipment including fans, ductwork, and necessary equipment to allow the existing air-handling equipment in each of the three large areas of the building to distribute this preheated air. A table of the major air-handling equipment in each area is provided in Table III.

TABLE III

MAJOR AIR-HANDLING EQUIPMENT

Building Zone	Floor Area (ft ²)	Volume (ft ³)	Major Supporting Ventilation Equipment
Basketball Stadium	47,124	2,780,316	AH-1 through AH-8, AH-10 AH-36, EF-1 through EF-5
Ice Hockey Arena	47,124	2,780,316	AH-11 through AH-18 EF-6 through EF-9
Multipurpose/Track	74,579	5,667,980	AH-20 through AH-31 EF-10 through EF-13

DOE-2.1A calculations show the saving of primary energy (at the source) at $10,543 \times 10^6$ Btu annually, assuming that the space is maintained at the current setting of $68^\circ F$. A no-cost option of lowering this setpoint to $65^\circ F$ would reduce this savings slightly.

C. Building 2410, Aeronautics Laboratory

There are three recommendations for the Aero Lab that meet the FY-1984 ECIP guidance for cost effectiveness: seasonal heating and cooling, revised control of the central multizone system, and evaporative cooling. Each is described below.

1. Seasonal Heating and Cooling. The heating and cooling systems for this building were designed to be available on an annual basis. However, DOE-2.1A simulations show that heating and cooling need only be provided seasonally and never simultaneously. We recommend that the heating system be shut down and that cooling be provided only during the summer.

This could be accomplished by turning on or off the hot water pumps P-1 and P-2 with a signal from an instrument sensing outdoor temperature. The same signal could be used to prohibit or permit the delivery of chilled water from Fairchild Hall.

DOE-2.1A calculations show the saving of 302×10^6 Btu of primary energy annually for the implementation of this strategy.

2. Demand Control. The central multizone system S1 maintains comfort in supported zones of the building by automatically modulating the mix of hot and cold air supplied through damper activity. Hot air is supplied at 100°F and mixed with cold air at 64°F. Revising the control of such systems to adjust the temperature of hot and cold deck coils usually results in substantial energy savings. The temperature adjustment is done by a comparing the demand for cooling or heating in each of the zones of the system. The temperature of the hot deck is adjusted to just meet the requirements of the coldest zone and the cold deck is adjusted to meet the requirements of the warmest zone. We recommend that a comparitor microprocessor be installed to perform this control.

Implementation would require the installation of a comparitor microprocessor and two linear thermostats. Signals from the room thermostats are already transmitted to the Mechanical Room for use in modulating zone dampers. Fig. 2 shows a possible interface with existing controls.

DOE-2.1A calculations show a saving of 272×10^6 Btu of primary energy annually. This assumes that Option 1 above has been previously implemented.

3. Evaporative Cooling. This opportunity involves the installation of an evaporative cooler in the Subsonic Wind Tunnel Room, and the addition of an air washer to the central multizone system S1. This opportunity presumes that the Subsonic Wind Tunnel room will no longer be served by system S1 because system S1 does not have sufficient capacity to condition this space. An independently controlled and evaporatively cooled ventilation unit is recommended to maintain the comfort conditions in this space. Currently, classroom experiments must be turned off orcasionally because of a severe overheating problem.

The implementation of this scheme will realize primary energy savings (calculated by DOE=2.1A) of 785×10^6 Btu annually, assuming that Options 1 and 2 above have been previously implemented. We recommend installation of both a 35,000 cfm evaporative cooler and an airwash spray system for the central multizone system S1.

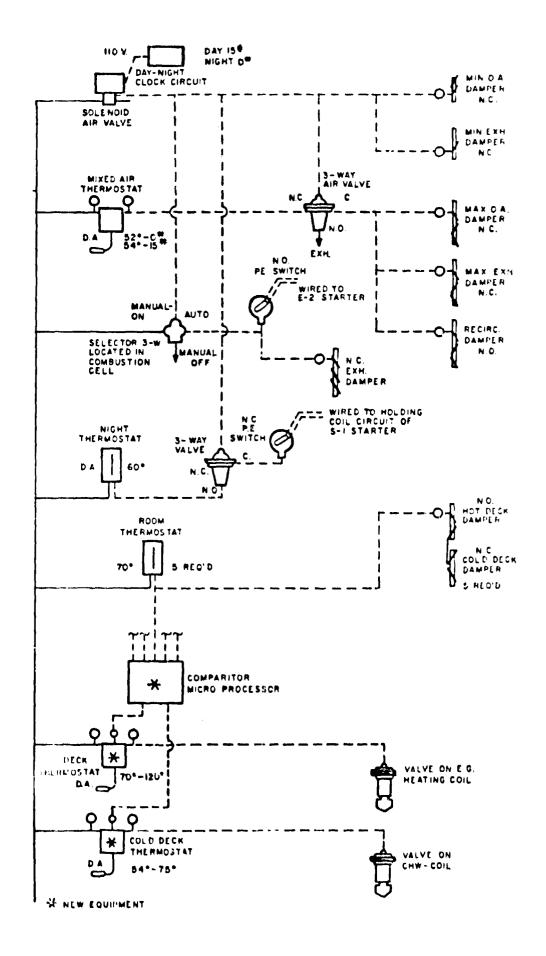


Fig. 2. Suggested revised controls for multizone system S1.

V. CONCLUSIONS

A summary of the recommended ECIP projects (including absolute and relative annual energy and cost savings, savings per invested dollar, discounted benefit/cost ratio, and life-cycle cost) is provided in Table IV for the three buildings studied. The funds (programmed amount) requested for the implementation of the recommendations of this study are \$1,947,700 for Vanderberg Hall to save 27,825 x 10^6 Btu's; \$795,214 for the Field House to save 10.543×10^6 Btu's; and \$102,504 for the Aero Lab to save 1.359×10^6 Btu's. These investments are life-cycle cost effective in accordance with established Department of Defense ECIP economic criteria. Although no solar projects are recommended, we have determined the energy and cost savings associated with the implementation of solar domestic hot water heating systems for all three buildings and a number of solar space heating options for the Aeronautics Laboratory (see Appendixes A and B). None of these solar projects are deemed cost effective at current fuel prices.

No attempt was made to rank these recommendations as to their cost effectiveness; ranking will be accomplished after a cost estimate of each recommendation has been prepared by the Air Force Academy. In our judgment, the cost of implementing each recommended ECO will be less than the programmed amounts requested.

TABLE IV
SUMMARY OF RECOMMENDED ECIP PROJECTS

	Option	Estimated Energy Use (Btu/ft ² /yr)	<pre>% Energy Reduction</pre>	Annual	imated Savings 10 ⁶ Btu	10 ⁵ Btu Saved per \$1000 Invested	Maximum Investment (\$)	Discounted Benefit/ Cost Ratio	Life-Cycle Cost <u>(\$1,000)</u>
ι.	Vandenberg Hall, baseline	120,834							
1.	Minimize ventila- tion rates	103,350	15	160	13,287	15.0	1,001,360	3.413	-2,417
2.	Run-around heat recovery combined with option 2	90,887	25	274	22,764	15.0	1,715,586	3.398	-4,114
3.	Improve fan/motor efficiencies combined with options 2 and 3	84,681	30	284	27,475	16.0	1,935,966	3.125	-4,114
4.	Reinstate econo- mizer combined with options 2, 3, and 4	84,217	30	284	27,825	16.1	1,947,720	3.114	-4,117
11.	Field House, baseline	138,281							<i>a</i>
1.	. Utility tunnel heat recovery	145,432	23	130	10,543	15.0	795,214	3.479	-1,971,126
111.	Aeronautics Labora- tor, adjusted baseline	462,846							
1.	. Seasonal heating and cooling	450,826	3	3	302	15.0	22,778	2.059	- 24
2.	Demand control combined with option 2	440,000	5	7	574	15.0	43,294	2.169	- 51
3.	Evaporative cooling combined with option 3	408,756	12	15	1,359	15.0	102,504	3.162	-222

APPENDIX A PERFORMANCE CALCULATIONS

I. BUILDING ENERGY ANALYSIS COMPUTER PROGRAM

The source program for this energy study is the Department of Energy's DOE-2 computer program for energy analysis of buildings. The particular version of DOE-2 used in this study is DOE-2.1A with modifications to incorporate a special subroutine that permits the SYSTEMS program to model spray coils, and another special subroutine that permits modeling of Trombe walls. This modified version of DOE-2.1A is operated through the Los Alamos National Laboratory's Central Computing Facility.

The computer program calculates the hour-by-hour energy use of the building, given information of the building's location, construction, operation, HVAC equipment, and primary energy conversion equipment. The program has four main computational sections: LOADS, SYSTEMS, PLANT, and ECONOMICS. The first three of these sections were used in this analysis. The economics were calculated separately using Air Force economic parameters. These computational sections are identified below, together with the major elements of the building system that must be addressed in the energy study.

- 1. LOADS: building envelope (exposed surfaces; that is, exterior walls, roofs, slab floors, windows), and internal loads (people, lights, equipment, and infiltration).
- 2. SYSTEMS: HVAC systems (ventilation loads, fan electrical loads, heating, and cooling loads).
- 3. PLANT: building central plant (heating and cooling equipment plus related equipment loads; total energy use with breakdown by energy category).

For all runs the Test Reference Year (TRY) weather tape for Denver, Colorado, was used instead of that for Colorado Springs because the latter was found to be incorrectly packed by the Control Data Corporation.

II. SPECIFICS CONCERNING INPUT DATA

A. Vandenberg Hall

1. LOADS input. The building was divided into seven zones based on the as-built drawing furnished by the Air Force Academy. Figure A-1 is an isometric view of Vandenberg Hall created by our DOE-2.1A version. Table A-1

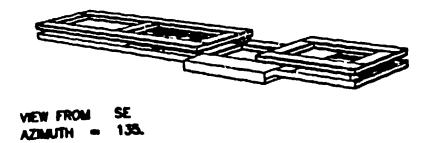


Fig. A-1. Isometric view of Vandenberg Hall.

TABLE A-I

Space Name	Location of Space	Areas Simulated
56 W	Units 1 and 2 of 5th and 6th floor	438 cadet rooms, toilets, laundry, corridor, storage, orderly room.
56E	Unit 3 of 5th and 6th floor	220 cadet rooms, toilets, laundry, corridor.
23W	Units 1 and 2 of 2nd and 3rd floor	436 cadet rooms, toilets, laundry, corridor, orderly room.
23E	Unit 3 of 2nd and 3rd floor	220 cadet rooms, toilets, laundry, corridor, orderly room, test cell.
23S	1st through 3rd floor	Mail, shops, storage, truck dock, cadet store, custodian, display, offices, supply, lobby.
23N	1st through 3rd floor	Model engineering display, radio club, chess, printing and finishing studio, reading, assembly, chaplian, conference, magazines, lyceum, hobby shop.
4	4th floor	Assembly, security flight, and IEO administration.

shows the assignment of space names to physical areas within the building and Fig. A-2 exhibits the architectural plan and elevation views of the building. The basement, which includes six mechanical rooms, piping tunnels, and electrical unit substations, was not simulated because it is not conditioned.

A series of LOADS sensitivity studies was completed to establish the energy problem in the building. The building was simulated as it is currently operated; it was then compared to LOADS simulations with different infiltration rates varying from 0.79 air changes/h to 1.85 air changes/h. The LOADS output for each run showed infiltration to be the largest component of the building load; consequently, a significant effort was made to calculate accurately the infiltration rates of the building. The ASHRAE crack length was used to estimate the infiltrate rate; different rates were calculated for each space simulated. These rates, when multiplied by the volume of the associated space, summed, and divided by the total building volume, yield an infiltration rate of 0.85 air changes/h for the entire building. This rate was applied to the base case building.

2. SYSTEMS input. The air distribution systems that support Vandenberg Hall are principally once-through air-handling systems that support the cadet living quarters. However, the assembly areas are supported by heating and ventilation (H and V) units that recirculate air within the space and the cadet store area is served by a multizone unit that also recirculates conditioned air. The three HVAC systems shown in Tables A-II through A-IV were input to simulate the distinct operational characteristics of the air distribution systems described above.

The CENTRAL system models the once-through ventilation system that supplies 70°F air to the cadet living quarters. The fans of this systems run 24 hours a day, 7 days a week. Baseboard heaters provide enough heat to maintain a 65°F daytime and 55°F nighttime temperature in the conditioned space. The baseboard thermal output is reset based on the outside air temperature.

The assembly areas served by the ASSEMBLY system were previously heated by a radiant floor panel system that has since been rendered inoperative. Consequently, the recirculating H and V units must now provide all of the heating. The spaces served are heated to 65°F during the day and 55°F at night. The fans are run continuously during the winter but are turned off in the summer. Demand control varies the temperature of air delivered to the

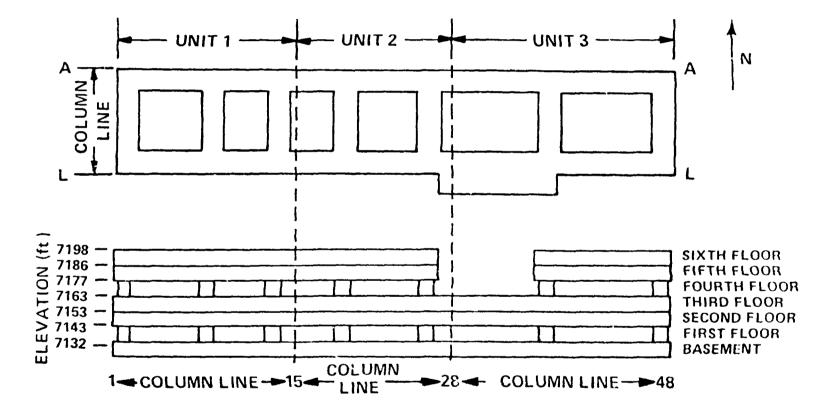


Fig. A-2. Architectural plan and elevation views of Vandenberg Hall.

TABLE A-II
ZONES SERVED BY CENTRAL HVAC SYSTEM

Zones	Area Served	Ventilation Rate (cfm)	Supporting Ventilation Equipment
23W	Toilets	19,600	HV-42, 43, 54, 55; EX-1 through 4, 6, and 7; EX-9 through 16.
	Storage	8,800	HV-42, 43, 54, 55; EX-20 and 21.
	Orderly	960	HV-1 and 2; EX-5 and 8.
23E	Toilets	7,480	HV-42, 43, 54, 55; EX-1 through 4, 6, and 7; EX-9 through 16.
	Storage	9,600	HV-42, 43, 54, 55; EX-22.
	Mechanical	10,400	HV-42, 43, 54, 55; EX-17.
	Test Cell	100	HV-42, 43, 54, 55; EX-40.
23N	Toilets	1,560	HV-3 and 4; EX-19.
	Storage	14,500	HV-3 and 4; EY-19.
	Hobby Shop	5,000	HV-8; EX-27, 32 and 34.
	Radio Listening	500	HV-7; EX-26.
	Dark Rooms	2,600	HV-6; EX-33.
56W	Toilets	19,520	HV-44 through 53; EX-1 through 4, 6, and 7; EX-9 through 16.
56E	Toilets	7,840	HV-44 through 53; EX-1 through 4, 6, and 7; EX-9 through 16.

TABLE A-III
ZONES SERVED BY ASSEMBLY HVAC SYSTEM

Zones	Area Served	Air Handling Capacity (cfm)	Supporting Air-Handling Equipment
4	Assembly	75,600	HV-10 through 39.
	Security Flight	4,500	HV-40 through 41; EX-50.
	IEO Administration	600	HV-56; EX-51.

TABLE A-IV
ZONES SERVED BY STORES HVAC SYSTEM

Zones	Area Served	Air Handling Capacity (cfm)	Supporting Air-Handling Equipment
201163	Area Serveu	(СТШ)	<u>Equ (pillerri</u>
235	General Supply	27,430	S-41; EX-35.

spaces from 55 to 120°F. An economizer cycle has been overridden by a field modification that permits the introduction of fresh air into the conditioned spaces only when the outdoor temperature rises above 60°F.

The STORES system models a 100% recirculation multizone air distribution system with direct expansion (DX) cooling. The conditioned spaces are controlled between 65 and 80°F all year round; the fans run 24 hours a day, 7 days a week. During the winter, an economizer cycle is overridden to permit the introduction of fresh air into the conditioned spaces only when the outdoor temperature rises above 60°F. During the summer (June, July, and August), a spray coil is activated to provide evaporative cooling, thus displacing mechanical chilling. Because DOE-2.1A is incapable of modeling evaporative cooling in conjunction with DX cooling, no ECO energy savings are reported for this system during the summer months.

The systems modeled do not include all of the air-handling systems in the building; those units supporting the lyceum, truck dock, and fireplace are infrequently used so they were not simulated. Furthermore, the fans for the unit substations, tunnels, and some toilet exhaust fans on the first floor were ignored because the spaces they served were unconditioned.

3. PLANT input. The high-temperature water supplied to the medium- and low-temperature water systems of Vandenberg Hall was simulated by the steam utility option of the DOE-2.1A program. Energy consumed at the source was calculated by hand by taking the DOE-2.1A results for steam consumption and dividing by an overall generation and distribution efficiency of 70%.

The entire cooling load for the building was met by a packaged multizone system for the STORES system. A dummy centrifugal chiller was specified in PLANT to keep the program from aborting.

B. Field House

1. LOADS input. The Field House was divided into three distinct areas based on thermal characteristics and usage. These three zones are (1) the basketball stadium, (2) the ice hockey arena, and (3) the multipurpose/track facility. Data used in the LOADS input were taken from an energy survey performed on the Field House that included a detailed review of the as-built drawings, a site survey, discussion of the building's operation and performence with the facility's personnel, and information on occupancy and lighting loads.

Figure A-3 is an isometric view of the Field House generated by the DOE-2.1A program. Figure A-4 shows the plan view of the building and the assignment of zone/space names to the physical areas within the building.

The results of the LOADS run show infiltration to be the largest component of the building load for all three zones, lighting to be the second largest component, and heat loss through the roof to be the third largest component.

2. SYSTEMS input. The Field House is served by several large air-handling units in each of the zones. These units normally function in a 100% recirculation mode to maintain the building at an average temperature of 68°F. During sports events, concerts, or other activities in which there would be a large number of people in the building, the units operate in a 100% ventilation mode in which outside air is brought into the building to meet the increased internal load.

The fans and heating coils in each of the three zones operate on an as needed basis to maintain the thermostat set point in each zone. The temperature of the air provided to the zone is modulated between 120 and 60°F.

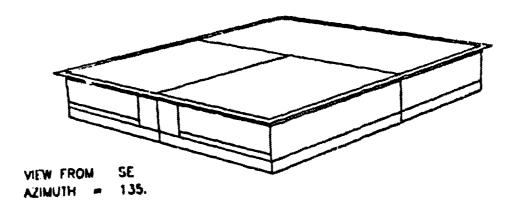


Fig. A-3. Isometric view of the Field House.

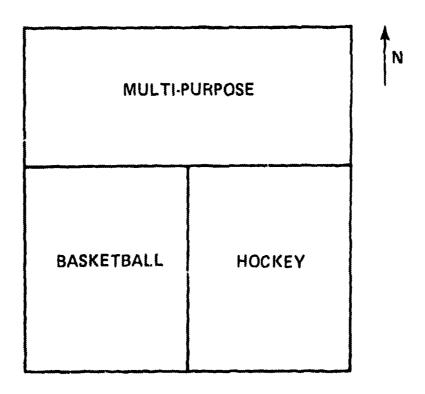


Fig. A-4. Plan view of Field House.

There is no cooling equipment for the building. Table A-V shows the heating and ventilating equipment that support each of the three zones.

TABLE A-V FIELD HOUSE ZONES

Building Zone	Floor Area <u>(ft²)</u>	Volume (ft ³)_	Major Supporting Air- Handling Equipment
Basketball Stadium	47,124	2,780,316	AH-1 through AH-8; AH-10; AH-36; EF-1 through EF-5.
Ice hockey arena	4/,124	2,780,316	AH-11 through AH-18; EF-6 through EF-9.
Multipurpose/track	74,579	5,667,980	AH-20 through AH-31; EF-10 through EF-13.

based on the outside air temperature. When a zone is operating in the ventilation mode and the outside air temperature is above 75°F, the air-handling units for that zone will return to the recirculation mode.

3. PLANT input. The high-temperature water supplied through converters to the ethylene glycol distribution system of the Field House was simulated by the steam utility option of the DOE-2.1A program. Energy consumed at the source was calculated by taking the DOE-2.1A results for steam consumption and dividing by an overall generation and distribution efficiency of 70%. A dummy centrifugal chiller was specified in PLANT to prevent the program from aborting.

An active solar system for the building's domestic hot water (DHW) load was simulated. Four parametric runs were made with varying values for the collector area, collector fluid flow rate, and storage tank volume. Approximately 77% of the building's DHW load can be met with 5000 ft 2 of collectors.

C. Aeronautics Laboratory

1. LOADS input. The building was divided into zones based on the internal loading, exterior surface type, solar exposure, and HVAC system type. Figure A-5 is an isometric view of the Aero Lab, as modeled, that was created by the development version of DOE-2.1A. Figures A-6 and A-7 contain a floor plan showing the zoning divisions. Schedules were input for lights, equipment, and people occupancy. Infiltration was assumed to occur only in the lobbies during the day as the central HVAC system supporting the rest of the building uses at least 12% fresh air during this period. This implied that the building

is under positive pressure. Some infiltration throughout the building was assumed to occur at night when the HVAC system is in the recirculation mode.

2. SYSTEMS input. Schedules for thermostat set points and HVAC outside air requirements were input. Because only one HVAC system is permitted per thermal zone, the lobbies were split into a skin zone serviced by the unit heaters and a central zone. Size, operating parameters, and outside air requirements and coil set points for all systems were determined from the drawings and field inspections.

Two developmental modifications to the DOE-2.1A SYSTEMS program were used to simulate two of the options. These include the spray-coil and evaporative cooling routine and the Trombe wall simulation routine.

3. PLANT input. The medium-temperature hot water was simulated using the utility option of the DOE-2.1A program. The energy use values reported are the number of Btu's of hot water required at the building boundary.

The chilled water demand was converted to equivalent high-temperature hot water and electricity demands by simulating a single-effect absorption chiller that was sized by the program to just meet the peak cooling load. The energy use values reported are the number of Btu's of hot water and electricity required to produce the needed chilled water at the building boundary.

III. SUMMARY OF PERFORMANCE RESULTS - VANDENBERG HALL

Fourteen ECO candidates were analyzed for Vandenberg Hall; thirteen of these involved conservation modifications and one involved a solar modification.

Conservation Option	<u>Description</u>				
2	Reinstate economizer operation for cadet store				
3	Zone thermostat control for baseboard heaters				
4	Tunnel preheat of ventilation air				
5	Reinstate radiant heating in assembly areas				
6	Run-around heat recovery loop				

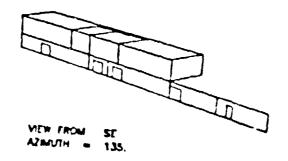


Fig. A-5. Isometric view of the Aero Lab.

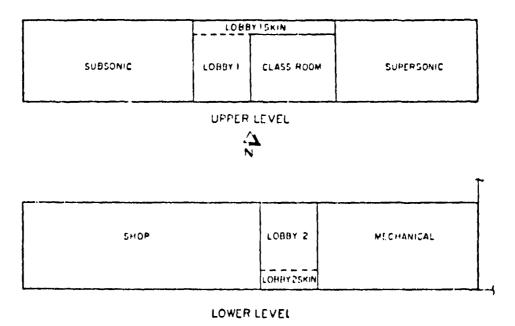


Fig. A-6. Plan view of the Aero Lab main buildings.

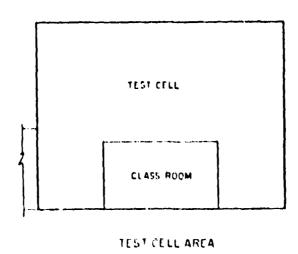


Fig. A 7. Plan view of a typical Aero Lab test cell.

Conservation Option	Description
7	Minimize ventilation rates
8	Improve fan/motor efficiency
9	Night insulation on windows
10	Improve wall and roof insulation
11	Combine options 6 and 7
12	Combine options 6, 7, and 8
13	Combine options 6, 7, 8, and 2
14	Combine options 6, 7, 8, 2, and 3
Solar Option	Description

2 Solar DHW system

The results of the computer analysis of these options are tabulated in Tables A-VI and A-VII. The individual options are discussed below.

A. Energy Conservation Opportunities (ECOs)

Table A-VI is a comparison of the energy conservation options considered and the expected energy consumption of each. An explanation of each follows.

- 1. Baseline building, as-built. A baseline building simulation was run on the existing building: energy consumed for heating was shown to be the predominant energy problem. The cooling load, by comparison, was shown to be quite small. The Building Boundary Energy Index was calculated at 55,800 Btu per gross square foot of floor area on an annual basis. This indicates that the building is very energy efficient and therefore difficult to retrofit with energy conservation features in a cost-effective manner.
- 2. Reinstate economizer operation for cadet stores. An econ mizer cycle providing free ventilative cooling was simulated in lieu of closed fresh air dampers associated with the multizone air-handling system supporting the cadet stores. These dampers were set by maintenance personnel to close when the cutdoor temperature dropped below 60°F.
- 3. Zone thermostats for baseboard heaters. This option involves the control of the thermal output of the baseboard heaters by individual zone

TABLE A-V1
ENERGY CONSERVATION OPTIONS VANDENBERG HALL

	Option	Heating Energy (10 ⁶ Btu)	Coaling Energy (10 ⁶ Btu)	Electric Energy (10 ⁶ Btu)	Building Boundary Energy Index (10 ³ Btu/ft -yr)
1.	Baseline, as-built	27,871	983	13,553	55.8
2.	Reinstate economizer	27,874	915	13,521	55.7
3.	Zone thermostats for baseboard heaters	26,024	983	13,404	53.2
4.	Tunnel preheat of ventilation air	25,854	984	13,531	53.1
5.	Reinstate radiant heating	28,092	983	13,067	55.4
6.	Run-around heat recovery loop	14,193	983	13,382	37.6
7.	Minimize ventilation rater	18,787	984	13,465	43.7
8.	Improve fan/motor efficiencies	27,871	983	12,237	54.1
9.	Night insulation on windows	27,388	994	13.537	55.7
10.	Improve wall and roof insulation	27,678	999	13,550	55.6
11.	Combine options 6 and 7	12,392	984	13,371	35.2
12.	Combine options 6, 7, and 8	12,392	984	12,053	33.5
13.	Combine options 6, 7, 8, and 2	12,398	915	12,021	33.3
14.	Combine options 6, 7 8, 2, and 3	11,393	915	11,494	31.8

TABLE A-VII

SOLAR OPTIONS
VANDENBERG HALL

Option		Heating Energy (10 ⁶ Btu)	Cooling Energy (10 ^h _Btu)	Electric Energy	Building Boundary Energy Index (10° B <u>tu/ft</u> -yr)
1.	Baseline, as-built	27,871	983	13,553	55.8
7.	Solar domestic hot water system	24,050	903	13,636	53,4

thermostats instead of the outdoor temperature reset control now installed. This strategy eliminates the overheating that often occurs with reset control.

- 4. Tunnel preheat of ventilation air. This simulation assumed that the building was pressurized to eliminate infiltration. Such a feature could be implemented by drawing in air from the adjacent high-temperature hot water utility tunnel and delivering 70°F air to the space. Hence, infiltration would be displaced by ventilation air preheated by the thermal losses of the high-temperature water piping within the utility tunnel system.
- 5. Reinstate radiant heating. The assembly areas were previously heated by a radiant floor panel system that has been rendered inoperative. This option involved turning off the heating and ventilation units that now serve these areas and reviving the floor panel system. Fan power savings are realized but higher thermal losses offset some of these gains.
- 6. Run-around heat recovery loop. A run-around heat recovery system was simulated operating at an overall effectiveness of 75%. This option assumes that heat from the exhaust of ventilation air from the CENTRAL system is recovered and used to preheat the makeup air. This option yields the largest uncoupled energy savings of any considered.
- 7. Minimize ventilation rates. The ventilation rate for the CENTRAL system was reduced from 108,460 cfm to 50,812 cfm. Acceptable air quality can still be maintained even at the lower rates. This option will most likely yield the largest energy savings for the lowest capital expenditure.
- 8. Improve fan/motor efficiencies. Fan power savings were realized by assuming that a 50% savings in fan/motor energy could be realistically achieved by installing new fans and motors.
- 9. Night insulation on windows. This simulation assumed that R-9 insulation was applied to every window of the building at night to minimize heat loss. This strategy was mistakenly applied to both the summer and winter periods and the results show the consequential rise in cooling energy requirements. However, only a small amount of heating energy is saved, so this option was not rerun.
- 10. Improve wall, floor, and roof insulation. We simulated the installation of an additional R=3 of insulation on roof and floors of this building. The thermal resistance of the exterior walls was improved from R = 7 to R = 14. The addition of insulation results in only insignificant reduction of heat loss

in both the winter and summer. Although there is some heating energy performance improvement, there is also a cooling penalty to be paid.

- 11. Combine options 6 and 7. This option involves the installation of a run-around heat recovery system in addition to the reduction of the ventilation rate for the CENTRAL system. Significant thermal energy savings are realized by this combination.
- 12. Combine options 6, 7, and 8. The thermal energy savings features of the previous option are combined with improved fan/motor efficiency to yield both thermal and electrical energy savings.
- 13. Combine options 6, 7, 8, and 2. The thermal and electrical energy savings features of the previous option are combined with the reinstatement of the economizer cycle for the cadet stores.
- 14. Combine options 6, 7, 8, 2, and 3. Option 13 is combined with thermostatic control of the baseboard heaters for only slight performance improvement and relatively large first cost.

B. ___ Solar Opportunities (ECOs)

Table A-VII compares the energy consumed by the baseline building to the energy consumed by the same building with a solar collector system of 40,000 ft² of collector providing 80% of the DHW energy requirements. Solar DHW systems generally cost about $$50/\text{ft}^2$$ of collector installed and cannot be justified unless fuel prices increase significantly.

IV. SUMMARY OF PERFORMANCE RESULTS - FIELD HOUSE

Six ECO candidates were analyzed for the Field House; five of these were conservation modifications and one was an active solar retrofit.

Conservation Option					
2	Pressurize building with preheated air				
3	Reduce thermostat set points in two zones				
4	Add insulation to building roof				
5	Combine options 2 and 3				
6	Combine options 2, 3, and 4				
Solar Option	Description				
2	Active solar DHW retrofit				

The results of the computer analysis of these options are shown in Tables A-VIII and A-IX. The individual options are discussed below.

A. Energy Conservation Opportunities (ECOs)

From the results of the energy survey and the DOE-2.1 simulation, an initial list of potential ECOs was compiled for the Field House. The ten potential ECOs for the Field House are as follows.

- (1) Passive solar Trombe wall on south side to preheat outside air.
- (2) Addition of insulation to roof of building.*
- (3) Addition of insulation to walls of building.
- (4) Reduction of lighting levels by the use of daylighting techniques (skylights).
- (5) Reduction of building thermostat set points (to 62°F).*
- (6) Active solar retrofit for the DHW load.*
- (7) Exhaust fan heat recovery loop.

wall insignificant (< 10%).

- (8) Pressurize the building with prewarmed air to offset infiltration losses.*
- (9) Recirculate warm air from the top of the high bays to the floor level.
- (10) Waste heat recovery from the ice rink chiller to heat domestic hot water.

 Outside air is brought into the building only during athletic and other events, and these occur most often at night. At these times, the amount of outside air required is so large as to make the contribution from a Trombe

The heating load caused by conduction through the walls was less than the load caused by conduction through the roof. It was decided to analyze the effect of adding roof insulation first, and if that turned out to be economically feasible, to then consider additional wall insulation.

If daylighting techniques are to be attempted for this building, they must be in the form of skylights through the roof, as any wall penetration would damage the architectural integrity of the building. Because of the height of the roof above the occupied space and the number of ceiling-level obstructions, there is insufficient light available through the use of

^{*}ECOs selected for further scudy.

TABLE A-VIII
ENERGY CONSERVATION OPTIONS
FIELD HOUSE

Option		Heating Energy (10 ⁶ Btu)	Cooling Energy (10 ⁶ (tu)	Electric Energy (10° Btu)	Building Boundary Energy Index (10 ³ Btu/ft ² -yr)
1.	Baseline	15,078	0	6,928	89.4
2.	Pressurize building	7,698	0	6,928	59.4
3.	Reduce thermostat setting	12,432	0	€,657	77.6
4.	Add roof insulation	14,045	0	6,855	84.9
5.	Combine options 2 and 3	6,129	0	6.769	52.4
6.	Combine options 2, 3, and 4	5,243	0	6,669	48.5

TABLE A-IX

SOLAR OPTIONS FIELD HOUSE

Option		Heating Energy (10 ⁶ Btu)	Cooling Energy (10 ⁶ Btu)	Electric Energy (10 ^h Btu)	Building Boundary Energy Index (103 Btu/ft -vr)
1.	Baseline	15,078	0	6,928	89.4
2.	Solar domestic hot water system (5000 ft? collector area)	14,678	ů	7,012	85.2

skylights to economically offset the daytime lighting energy. The building has already undergone two delampings and is currently operating at a very efficient lighting level.

Because the exhaust fans are running only when the building is in a ventilation mode and does not require additional heat, a heat recovery loop on the exhaust fans is not practical. The installation of fans to destratify air in the zones is also unnecessary because the building normally operates in a fully mixed 100% recirculation mode.

Water leaves the condenser of the ice rink chiller at approximately 68°F, too low a temperature to preheat domestic hot water. Table A-VIII is a comparison of the energy conservation options considered for further study and the expected energy consumption of each. An explanation of each option follows.

- 1. Baseline building, as-built. A baseline building simulation was run on the existing building, and energy loss caused by infiltration was shown to be the largest component of the building energy consumed for heating. The Building Boundary Energy Index was calculated at 89,438 Btu per gross square foot of floor area on an annual basis. This high number results from the very large volume of the building in comparison with its floor area.
- 2. Pressurize building with preheated air. The building was simulated assuming a supply of preheated outside air that would offset 60% of the infiltration losses. The air would be preheated by being drawn through the high-temperature hot water utility tunnel adjacent to the building. Heat recovery equipment including exchangers, fans, and ductwork would be installed to allow the existing air-handling equipment in each of the zones to distribute this preheated air.

Calculations were made assuming a 350°F water temperature, two 6-in.-diam pipes per utility tunnel, 1-1/2 in. of insulation on the pipes, and a maximum of 10 mph air flow in the tunnels. Using these assumptions and a 70 degree day base, it was estimated that approximately 4000 linear feet of tunnel would be required to obtain the necessary amount of preheat. The high energy savings and economic payback for this ECO make it an attractive retrofit project.

It has been learned that subsequent to this study, the Air Force Academy completed a retrofit project to install an additional 2 in. of fiber glass to the water pipes in the utility tunnel adjacent to the Field House. The reduced heat loss available for recovery would increase the length of utility tunnel required to 13,400 linear feet.

- 3. Reduce thermostat set points in two zones. Reduction of thermostat set points in the basketball stadium and the multipurpose/track facility from 70 and 65°F, respectively, to the set point currently maintained in the norkey rink (62°F) was simulated. This is a no-cost option and is recommended for immediate trial implementation to determine if the 62°F temperature proposed does not cause discomfort to the building's occupants.
- 4. Add insulation to building roof. The addition of 4 in. of insulation to the roof of the building was simulated. This option reduced only the heating energy loss caused by conduction through the roof, which was a minor contributor to the total building loss. This is an expensive option with relatively low energy savings.
- 5. Combine op:ions 2 and 3. The thermal energy savings of providing preheated air to offset infiltration losses was combined with a reduction in thermostat set points to yield both thermal and electrical energy savings.
- 6. Combine options 2, 3, and 4. Option 5 is combined with the addition of roof insulation for additional thermal and electrical energy savings.

 B. Solar Opportunities (ECOs)

Table A-IX compares the energy consumed by the baseline building with the energy consumed by the same building with a 5000 ft 2 active solar collector system providing 77% of the DHW energy requirements. Solar DHW systems generally cost about \$50/ft 2 of collector installed and are therefore too expensive for the energy saved to be economically justifiable.

V. SUMMARY OF PERFORMANCE RESULTS - AERONAUTICS LABORATORY

Eleven ECO candidates were analyzed for the Aeronautics Laboratory; six of these involved conservation modifications and five involved solar modifications.

Conservation Option	Description			
3	Seasonal heating and cooling			
4	Night setback in lobbies			
5	Demand control			
6	Evaporative cooling			
7	Combine options 3 and 5			
8	Combine options 3, 5, and 6			

Solar Option	<u>Description</u>		
2	Daylighting		
3	Trombe wall		
4	Sunspaces for the test cell class rooms		
5	Active solar heating system		
6	Solar domestic hot water heater		

The results of the computer analysis of these options are tabulated in Tables A-X and A-XI. The individual options are discussed below.

A. Energy Conservation Opportunities (ECOs)

Table A-X is a comparison of the energy conservation options considered and the expected energy consumption of each. An explanation of each option is included below.

- 1. Baseline building, as designed. A baseline building simulation was run on the existing building using information obtained from drawings and a site visit. Results of this simulation and the site visit indicated a severe overheating problem in the room with the subsonic wind tunnel. This overheating was resulting in overcooling of other areas in the building as the heating and cooling systems attempt to keep that single room under control.
- 2. Adjusted baseline building. The baseline building from (1) above was rerun to incorporate all of the operational changes that could be made in this building at no capital cost to the Air Force. Furthermore, the installation of a separate air conditioning system in support of the subsonic wind tunnel area is assumed in this simulation to create a climate conductive to education. Increasing the size of the multizone system currently supporting this area will not correct the overheating problem in this room because the existing cooling coil, fan, motor, and ductwork are not adequate to handle the required increased air flow. This adjusted baseline was used for comparison of all other options because it represents the actual required energy consumption for the existing configuration.

This simulation assumes that the thermostats in the Shop, Combustion, Trisonic, and Lobby-1 areas are adjusted to control the temperature within these spaces between 68 and 78°F; that is, controlling over a 10°F throttling range during the day. At night, the multizone fan supporting these zones is shut off, but cycles on as needed to keep the temperature in these spaces above 60°F. The fan operation remains unchanged from the baseline simulations.

TABLE A-X

ENERGY CONSERVATION OPTIONS
AERONAUTICE LABORATORY

Option		Heating Energy (10 ^h Btu)	Cooling Energy	Electric Energy (10° Btu)	Building Boundary Energy Index (10 ³ Btu/ft ² -yr)
1.	Baseline, as designed	1176	590	2430	167.0
2.	Adjusted baseline	992	554	2633	166.3
3.	Seasonal heating and cooling	888	467	2625	15%,4
4.	Night setback in loobles	956	548	2636	164.8
5.	Demand control	758	511	?634	155.3
6.	Evaporative cooling	1540	148	2624	171.6
7.	Combine options 3 and 5	698	462	7627	150.7
8.	Combine options 3, 5, and 6	698	0	≥592	130.9

TABLE A-XI SOLAR OPTIONS AFRONAUTICS LABORATORY

	Option	Heating Energy (106 Btu)	Cooling Energy (10 ⁶ Btu)	Electric Energy (10 ⁶ Rtu)	Building Boundary Energy Index (10 ³ Btu/ft ² -yr)
1.	Adjusted baseline	992	554	2633	166,3
2.	Daylighting	1059	546	2489	162.9
3.	Trombe wall	887	522	2618	160.3
4.	Sunspace for tert cell class rooms	959	555	7 632	164.0
5.	Active solar heating	270	554	2648	138,2
6.	Solar DHW, 120 ft ² , 215 gal.	992	554	2621	165.9

but the temperature control was originally designed to maintain 70°F during the day and 60°F at night. These thermostats are currently set at 68°F during the day and 60°F at night.

The thermostat control of temperature in the test cell classrooms is adjusted to the same operation specified for the Shop, Combustion, Trisonic, and Lobby-1 areas. Historically, the test cell classrooms were maintained at 72.5 ± 2.5 °F during the day and 62.5 ± 2.5 °F at night and are currently set at 68°F during the day and 60°F at night. The fan operation remains unchanged.

In this simulation, the subsonic area is uncoupled from the multizone fan system currently supporting it and the Shop, Combustion, Trisonic, and Lobby-1 areas. The Subsonic room is heated when the temperature drops below 68°F in the day and 60°F at night. Cooling is provided when the temperature exceeds 78°F; a two position thermostat with a 10°F deadband is assumed to maintain this control. A single zone heating and cooling system continuously delivers 35,000 cfm of air during the day; at night the fan is shut off but cycles on automatically to keep the space above 60°F.

Finally, the hot and cold deck temperatures for the multizone system are adjusted from 120 to 100°F for heating and from 54 to 64°F for cooling. Our simulations show that thermal comfort is not reduced by this adjustment and that energy waste is avoided by not mixing air that is too hot with air that is too cold.

- 3. Seasonal heating and cooling. The option automatically shuts down the heating system whenever the outdoor temperature exceeds a certain setpoint (say 60°F) and starts the cooling system. Conversely, the opposite occurs when the temperature drops below that setpoint; that is, the heating system is initiated and the cooling system is shut down. This can be accomplished by interlocking the electric power supplied to the hot water pumps P-1 and P-2 with an outdoor temperature sensor. The cooling system must be controlled with a pneumatically operated isolation valve also interlocked with the outdoor temperature sensor. This option eliminates simultaneous heating and cooling in the multizone system S1 without reducing occupant comfort.
- 4. Night setback in the lobbies. Two unit heaters support the lobbies on the first and second floor of this building. Each is set to maintain a continuous 68°F temperature within the space. These unit heaters were setback to 60°F at night in the simulation. Although energy is saved by this setback.

the maximum investment allowable is only \$3,695; consequently, this option is not recommended for implementation.

5. Demand control. This option involves adjusting the temperature of the hot and cold deck coils of the central multizone system. This temperature adjustment is done by a comparison of the temperature of each zone in the system. The temperature of the hot deck will be adjusted to just meet the requirements of the coldest zone and the cold deck temperature will be adjusted to just meet the requirements of the warmest zone. This strategy can result in an energy savings if either coil set point is not at an optimum temperature or if the optimum temperature changes.

Implementation would require installation of a comparitor microprocessor to compare the zone temperatures and to control the existing coil valves. These temperatures are already transmitted to the mechanical room for use in modulating the zone dampers.

This strategy would involve a relatively low investment and results in a 24% savings in heating energy and a 1% savings in cooling energy, representing the greatest savings of any single option considered.

6. Direct evaporative cooling. This option involves installation of an evaporative cooler in the Subsonic Wind Tunnel Room and addition of an air washer to the main S1 system in the Mechanical Room.

Evaporative cooling in these two area reduces the mechanical cooling requirements but, because of the uncontrolled cooling output of the evaporative cooling systems, the heating is increased. A two-speed fan for both evaporative systems would reduce the heating requirement.

- 7. Combine options 3 and 5. This option combines seasonal heating and cooling and demand control of the multizone system S1. See (3) and (5) above.
- 8. Combine options 3, 5, and 6. This option combines seasonal heating and cooling, demand control of system S1, and evaporative cooling in system S1 and the Subsonic Wind Tunnel Room. See (3), (5), and (6) above.

This combination is particularly advantageous because it prevents the heating system from tempering the uncontrolled output of the evaporative cooling systems. Evaporative cooling is assumed to operate only after the heating system is turned off. The installation of a two- or three-speed fan could reduce the overcooling that occurs during the spring and fall.

This combined strategy results in the largest energy saving of any of the options or combination of options analyzed. Furthermore, this strategy allows the building to be completely severed from the cooling water supplied from Fairchild Hall. The ventilative and evaporative resource at this site is sufficient to meet the cooling requirements of the Aeronautics Laboratory.

B. Solar Opportunities (ECOs)

Table A-XI is a comparison of the solar options considered. The table includes the expected energy consumption of the building when retrofitted with each option. An explanation of each option is included below.

- 1. Adjusted baseline. See explanation under Item 2 of the Energy Conservation Opportunities.
- 2. Daylighting. Lighting levels were reduced to 1.2 watts/ft² to assess the potential daylighting savings; this action would involve installation of windows or skylights. This option only slightly decreases the cooling and electrical energy consumption and slightly increases the heating energy requirements. Because implementation of this option would require major architectural changes and result in very little savings, it is not recommended as a candidate ECO.
- 3. Trombe wall. An unvented Trombe wall was modeled in the existing south facing walls of the lower and upper level lobbies, shops, classroom, storage, and trisonic rooms. The Trombe wall was assumed to be constructed of double pane glass and the walls were painted flat black. The glazing was assumed to be shaded during the summer.

The amount of energy displaced by the 4,362 ft² of Trombe wall simulated would not justify an investment of more than \$4.00 per square foot of glazing. Therefore, this option is not recommended as a candidate ECO.

4. Sunspace for the test cell classrooms. The entry ways to the test cell classrooms were converted into sunspaces by eliminating the exterior concrete walls in front of the test cell classrooms and replacing them with double-glazed patio doors and applying R-9 insulation at night.

The amount of energy displaced by the 637 ft² of vertical glazing simulated would not justify an investment of more than \$5.25 per square foot of glazing. Therefore, this option is not recommended as a candidate ECO.

5. Active solar heating system. An active solar water heating system was added assuming that all of the hot water coils in the conventional heating system would be replaced by larger coils delivering their rated output with

solar heated water supplied at $120^{\circ}F$. The solar system consists of approximately 6,000 ft² of single-glazed, selective-surface, flat-plate collectors, and a 10.800-gal. storage tank.

This option can supply as much of the space heating need: of the building as desired by adjusting the size of the collectors and storage tank. The 6,000 ft² of collectors with 10,600 gal. of storage would provide 73° of the space heating requirements of the building with only a slight increase in electrical energy consumption. However, the cost of implementing this option would more than exceed the economic benefit of the fuel savings over the assumed 25-year economic life of the solar collecting system.

6. Solar DHW heater. A solar DHW heater was added to the adjusted baseline to supplement the electric DHW heaters. A very minor decrease in electrical consumption was achieved as the DHW load is a very small part of the load. This option is not recommended as a candidate ECO.

VI. BASELINE COMPUTER MODEL LISTINGS

The baseline computer input for Vandenberg Hall, the Field House, and the Aeronautics Laboratory is attached as pages 42-81.

81/09/14 15:26:04 LPL PUN 1

```
3 •
        TITLE LINE-1 = . VANDENGERG HALL .
              LIME-2 = . AIR FORCE ACADEMY .
 5 .
              LINE-3 = * COLORADO SPRINGS, COLO *
        PUN-PERTOD=JAN 1 1978 THRU DEC 31 1978 ...
 5 .
      AROPT EPRORS
 3 .
      DIAGNOSTIC CAUTIONS ...
 Fa .
10 .
        BUILDING-LOCATION
                                               LONGITUDE - 105
                              EATITUDE=39
11 .
                              ALTITUDE = 7150
                                               TIME - ZONE = 7
17 •
                              AZIMUTH=0
17 .
14 .
                $ SCHEDULES $
15 .
        $ DRAPES $
15 .
          DS 1-DAY -SCHEDULE
17 .
            (1,7) (0,84) (8,18) (1,0) (19,24) (0.64)
          DRAPESCHED-SCHEDULE THRU DEC 31 (ALL) DS1 ...
10 .
12 .
        $ PEOPLE $
:0 .
          DS2-TAY-SCHEDULE
            [1,71[,77](8,16)(,14)(17,18)(,88)(19)(,06)(20,24)(,88) ...
21 .
27 +
          DS3-DAY-SCHEDULE
23 .
            {1.7}{.7}{.7}(8){.07}(9,11){.66}(12){.07}(13,18){.22}(19){.07}
            (20,24)(,79)
2.4
          DEDSCHED-SCHEDULE THRU DEC 31 (ND) DS2 (WEH) DS3
25 •
75 .
          DSS-DAY-SCHEDULE
27 .
            (1.7)(0)(8.12)(0.5)(13)(1.0)(14.18)(-9)(19.24)(0)
          PEGSCHEDZ-SCHEDULE THRU DEC 31 (ALL) 056 ...
28 .
23 .
761 .
        DOR-DAY-SCHEDULE
71 .
          (1,7)(-25)(8,14)(.12)(15,16)(1,0)(17,18)(-25)(19)(.05)
32 .
          120,24)£ 25)
77 .
        DSD DAY SCHEDINE
34 .
         -(+,7)(,25)(8,46)(,42)(47,48)(,25)(49)(-05)(20,24)(-25)---
75 .
        PERCUMBRESCHEDULE THRU DEC 3: (WD) DSR (WEH) DS9 ...
76, +
        D5 10 FOA + SCHEDULE (1, 12)(0)(13, 16)(1)(17, 24)(0)
77 .
        DS:11-DAY-SCHEDULE (1.24)(0)
70 .
        PERSCHEDA & SCHEDULE THRU DEC 31 (ND) DS10 (NEH) DS11
33 .
11: 0
        $ LIGHTS $
          DST-DAY-SCHEDULE
41 .
42 .
            (1,7)(0,1)(9,16)(0,2)(17,18)(0,55)(19,24)(1,0)
47 -
          LIGHTSCHED-SCHEDULE THRU DEC 31 (ALL) DS4
44 .
          DS7-DAY-SCHEDULE
           (1,7)(0)(0,18)(1,0)(19,24)(0)
45 .
          LEGSCHEDESCHEDULE THRU DEC 31 (ALL) DS7 ...
45 .
49
        $ 5311875 $
43 .
          DSS-DAY-SCHEDULE
            (1,5)(0)(6)(1)(7,21)(0)(22,24)(1)
50 .
          SPOSCHED=SCHEDULE THRU DEC 31 (ALL) DS5
5: •
52 .
        $ PRINT $
57 .
          PRINTSCHED = SCHEDULE THRU HAY 5 (ALL) (1,21) (1)
                               THRU MAR 31 (ALL) (1,24) (0)
54 •
                               THRU AFR 5 (ALL) (1,24) (1)
55 •
                               THPU DEC 31 (ALL) (1,24) (0)
55 .
```

4

```
• 58 •
                     $ EARERS $
               CAYSTELAYERS MATERIAGE (BROT, INTT. INTO, COC)
  • 59 •
    60 •
               LAYS2=LAYERS MATERIAL=(CC13, IN71, IN76, CCU6)
    61 .
              LAYSS=LAYERS MATERIAL = (CCCS, INSS)
  · 62 ·
               LAYS4=LAYERS MATERIAL=(CCO6.IN41,AL11,STO1)
   53 •
                    $ CONCIRUCTION $
    54 .
    65 •
              CONSWINDOW-CONSTRUCTION.
    65 •
                HI VALUETO 135 ABSTO.3 ...
  • 67 •
              CONSREGESSW-CONSTRUCTION
    E .
                 A FPS-LAYST
    63 .
               CONSELORS6#=CONSTRUCTION
    70 •
                 1 A FERSELATED
    7 * •
              GLAZING=GLASS-T+PE
     72 •
                PANES=2 G-T-C=6
              GLAZING2=GLASS-TYPE
    ....
                PANESTI GITICES G-CTO 5
              CONSUGNECONSTRUCTION LAYERS=LAYSR
    76 •
               CONSIDER TO CONSTRUCTION LAVERS = LAYS4
               IWALL=CONSTRUCTION U-VALUE=0.32 ...
     77 .
     78 .
     73 •
                    $ SPICE CONDITIONS $
     80 .
              COMPREHESPACE CONUITIONS
     91 .
                MILMEER-OF PEUPLE-ROG
    82 .
                + FORLE-HEAT GAIN-4001
                PEOPLE - SCHEDULE = PEOSCHED
     83 .
    24 .
                LIGHTING-W/SQFT-0.75
    P5 •
                 LIGHTING-TYPE=INCAND
                 LIGHTING - SCHEDULE = LIGHTSCHED
    8E •
    87 •
                 SOURCE-BTU/HR=1092500
-CAUTION--- VALUE GREATER THAN MAXIMUM OF
                                          0.1000E+07
    29 •
                 SOURCE - LATENT = 0.3
    84 •
                 SOUPCE-SENSIBLE = 0.3
                 SOURCE - SCHEDULE = SRISCHED
  • 30 •
    91 .
                THE - METHOD - AIR - CHANGE
                 AIR-CHANGES/HR=0.25
    32 .
    33 .
                 TEMPERATUPE = (65)
    9.1
                 FLOGR-WEIGHT=175 ...
    95 .
              COMPSSEESPACE-CONDITIONS LIKE #CONDSSW EXCEPT
    96 •
                 NUMBER-OF-PEOPLE=400 SOURCE-BTU/HR=546250
    97 •
    98 •
               COND23W=SPACE-CONDITIONS LIKE-COND56W ...
  • 99 •
  · 100 ·
              CONDICATE SPACE - CONDITIONS LIKE - CONDICE ...
  101 •

    .02 •

              COTO235=SPACE CONDITIONS

 103 =

  · 104 ·
                 THMCERATURE = (65)
 • 105 •
                 MAJMBER-DE PEOPLE-60
                 PEOPLE-HEAT-GAIN=400
  • 10,5 •
                 PEOPLE - SCHEDULE - PEOSCHED2
 · 107 ·
  · 108 ·
                 EIGHTIMG-W/SUFFE2 0
                LIGHTING-TYPE-INCAND
 · 109 ·
 · 110 ·
                 I TOHTING SCHEDULE FLEGSCHED
 . 111 .
                 EWJIPMENT - W/SUFT-0 75
 • 1:2 •
                 ENUIP - SCHEDULE - LEWICHED
 • : 13 •
                 INF -METHOD: AIR-CHANGE
                 INF CEM/SQFT=0.0
 . 114 .
 . 115 .
                 FLOOR-WEIGHT=175 ...
```

చ

- 116 -

```
CONCERN: SPACE - CONDITIONS
. : : 7 -
             TEMPERATURE TISS 1
. 118 .
             MUMBER-OF PERPLES 100
* 113 *
             PEOPLE-HEAT GAIN-400
120 +
             PEOPLE - SCHEDULE - PEDSCHEDS
4 121 *
· 122 ·
             EIGHTING-W/SQET-1.0
* 1,3 *
             LIGHTING-TYPE-INCAND
* 124 *
             LIGHTING-SCHEDULE-LIGHTSCHED
• 125 •
             EGHIPMENT-W/SQFT=0.75
· 125 >
             FOUTP-SCHEDULE=LEGSCHED
* 127 *
             INF - METHOD-ATR - CHANGE
             AIP-CHANGES/HR-0.25
* 128 ×
· 179 ·
             FLOOR-WEIGHT=175 ...
• 130 •
. 131 .
             COMPARSHAGE - COMPARTIONS
. 577 .
             NUMBER - OF - PEOPLE - 500
• 133 •
             PEOPLE-HEAT-GAIN-400
• 134 •
             PERIOLE - SCHEDULE - PERSCHEDA
* 175 *
             1. IGHT ING-W/SQFT-1 0
* 135 *
             LIGHTING-TYPE TINGARD
. 137 .
             LIGHTING-SCHEDULF = PEDSCHED4
* 138 *
             SDURGE-810/HR=10000
* 139 *
             SOURCE - SCHEDULE - PERSCHEDA
             INF - METHOD - A IR - CHANGE
· 140 ·
             ATR-CHANGES/HR-G.25
. 141 -
* 142 *
            TEMPERATURE=(55)
+ 143 +
             FLOOR-WEIGHT=175 ...
* 144 *
• 145 •
                   $ SHADING SUPPACES $
• 145 •
             556W-F1:8 S
* 147 *
              H-17.3 W-146 X=49.9 Y=50 Z=44.5 AZ=90 TT!T=90
· 132 •
             556% N1-B-S
              #1-17 3 W-315 X=365 Y=49 9 Z=44,6 A7=0 [[LT=90
. .49 .
* 150 *
             5559-W2-R-S
              HE17 3 WE146 X=365, 1 Y-196 Z-44,6 AZ-270 TILT-90
. +5.7 .
             5508-E2-R 5
. 157 .
• 157 •
              44-17.3 W=146 X=411.9 Y=50 Z=44.6 AZ=90 TILT=90 ...
. 15A .
             S56# NR-8-5
» 155 •
              H-17 3 W-316 X=731 Y=49,9 Z=44 F A7-0 TILT-90
• 155 •
             556W-W3-B-5
· 157 ·
              H-17,3 W=146 X=731,1 Y=196 Z=44,6 AZ=270 TILT=90
. ...
             555F F1=8-5
. :53 .
• 150 •
              H-17 3 W-146 X=1057.9 Y=50 Z=44.6 AZ=90 TILT=90
             556E-41-8-5
. 161 .
              H: 17 3 W:230 K:1288 Y:49 9 Z:44.6 AZ:0 111,1:90
· 'C7 •
             SSEE-#2-8-5
+ 163 +
              -H-17 3 W=146 N=1288.1 V=196 Z=44 6 AZ=270 FILT=90 .
· 164 •
. 155 .
             STORW FIFE S
. 165 .
. 167 .
              H-50 W-781 X-0 Y-0 Z=44.5 AZ-180 TILT-0 ...
. 169 .
             5564 F3-8-5
· 169 ·
              H-146 W-50 X-0 Y-50 Z=44 5 AZ-190 FIET-0

    170

             SSOW-FITHES EINFESSOW-F3 EXCEPT *- 165
. 171 .
             SERM-15-H-S LIKE-55RW-F3 ENGERT Y-731
• 172 •
> 173 -
             SERF-F1:R-S H=50 W=330 X-100R Y-0 Z-44 5 AZ-180 FI: I-0
             SSAE-FRES TIRE-SSAE-FT EXCEPT TO 196
. 174 -
             SSEE-F3-R-S LIKE-SSSE-F1 EXCEPT Y-50 H-146 W-50
• 175 •
             $58E-F4=8-5 LIKE=$56E-F3 EXCEPT X=1289
. 176 .
+ 177 ·
```

527WE-5-8-5

· 178 ·

4

```
. :91 .
              5238-81-8-5 LIKE-S568-81 E46801 7-11,2 H-18 4
  · 192 •
              500F-W2-8 5 LIME-556E-W2 FM5EDT Z-11 2 H-18,4
  . 197 -
             523F-N2=8-5 LIKE=556E-N1 E*CEPT Z=11 2 H=18.4 ...
  . 184 .
  . 125 .
             523W-E1-P S LIKE $56W-E1 FROEPT H-18 4 7-11 2
  . 105 .
             5234-45-8 S : IKE-523W E1 E*CFPT Y 711 1 += 196 A2-270
 • 187 •
            5564 56=8-5 F=0 Y=196 7=44 5 A7=190 FH L=0 H=50 W=781
  • 188 •
            5566-F5=8-S x=1008 Y=196 Z=44.5 AZ=180 TILT-0 H=50 W=330 ...
 . 189 .
            $4##8-5 x=50 r=206 Z=31 AZ=180 TILT=90 H=14 W=304
 • 130 •
            54E=8-5 X=1058 Y=206 Z=31 AZ=180 TILT=90 H=14 W=133 G
  . 191 .
 * 132 *
                   $ FIFTH & SLXTH FLOORS - WEST $
 . 193 .
 • 194 •
           ZONE 56W = SPACE
 * 195 *
            X=0 Y=0 Z=44,6 AZ=0 AREA=2000000 VOLUME=17000000
-CAUTION--- VALUE GREATER THAN MAXIMUM OF ... 0.1000E+06
-CAUTION--- VALUE GREATER THAM MAXIMUM OF ... O. 1000F407
 . 136 .
             SPACE-CONDITIONS=CONDS6W ...
 · 197 •
 . 139 .
           EMSSA-Witzel-#
 · 199 •
            CONSTCONSWINDOW S-F-F-0 5 X-0 Y=246 Z-0 AZ-270
 • 200 •
             TILT=90 HEIGHT=17 3 WIDTH=246 G-F F=0.5

    201 •

           WINSSW-WirWINDOW

    202 •

             G-T-GLAZING X=0 (+5.92 H=5.466 W-246 S-F-F-0 5
 · 203 ·
             CONDUCT-SCHEDULE=DRAPESCHED G-F-F=0.5 ...
 · 204 ·
           EW564-W2=F-W
 • 25.5 •
            - CONS=CONSWINDOW | S-F F=0.42 | X=365 | Y=196 | Z=0 | AZ=270
 . 206 .
 . 207 .
             TILT=90 H=17.3 W=146 G-F-F=0 58 ...
· 208 •
           WINSSW-W2=WINDSW
 · 209 ·
             LIKE#WIN56W-W1 EXCEPT W=146 S-F-F=0 42 G-F-F=0,58
 . 210 .
 • 211 •
           FW56-W3TE-W LIKETEW56W-W2 EXCEPT X=731
           WINSEM-W3=WINDOW LIKE=WINSEW-W2 ...
 · 212 ·
 • 2:3 •
 • 214 •
           EW56W-E1=E-W
 · 215 ·
            LIKETEW56W-W2 EXCEPT XTEO Y=50 AZ=90 ...
 · 215 ·
           WIN56W-E1=WINDOW G-T=GLAZ(NG X=0 Y=3 38 H-10 54 W-146
 . 217 .
            SEFEFEO.42 CONDUCT-SCHEDULE DRAPESCHED GEF FEO 58
 + 218 ·
 • 219 •
           EWS6W-E2=E-W LIKE=EWS6W-E1 EXCEPT X=415 ...
 • 220 •
           WINSOW-E2=WINDOW LIKE=WINSOW-E1
 • 221 •
           EWS6W-E3=E-#
 * 222 *
            LIFE=E4564 WI EXCEPT X=781 F=0 AZ=90
 · 223 •
           WINSOW-E3:WINDOW LIKE:WINSOW-W1 EXCEPT 1:3 38 Ht to 54
 · 224 ·
 · 225 ·
 · 226 ·
           EWSON-NITE-W
 · 227 ·
             LIKE=EW56W-E1 EXCEPT X=365 Y=50 AZ=0 W=315 S-F-F-0 45
 · 228 ·
 · 229 ·
           WIN56W-N1=WINDOW LIKE=WIN56w-E1 Except W=315 S-F-F-O 45
 · 230 ·
               G-F-F=0.55
 • 231 •
 • 232 •
           E. 55W-N2TE-W LIKE=EW56W-N1 EXCEPT x=781 Y=246 S-F F-0 5 W-781
 • 233 •
               G F-F=0 5 ...
 · 234 ·
           WINSOW-N2=WINDOW LIKE=WINSOW-E1 EXCEPT W-781 S F F D 5
 · 235 ·
               G-F-F=0.5 ..
 · 236 ·
```

```
· 237 ·
           EWSGW NAME M FIRE-EMSGM-N1 EXCEDT MESTE ASSAULT
• 238 •
           WIN56W-N3=WINDOW LIKE=WIN56W-N1 EXCEPT W=316
• 239 •
•. 240 •
           EWS6W SITE W LIMETEWS6W-N2 EXCEPT X=0 YTQ AZTIRO ...
• 241 •
           WINSOW-SI=WINDOW LIKE=WINSOW-N2 ...
· 242 ·
• 243 •
           EW56W 52-F-W LIKE=EW56W-S1 EXCEPT X=50 Y=196 S-F-F-0 45 W=315
· 244 ·
· 245 ·
               G-F-F-0.55
• 245 •
           WINSOW-S2=WINDOW LIKE=WINSOW-N1 ...
· 247 ·
           FW56-53-E-W LIKE FW56W-52 EXCEPT X-415 W-316 ...
• 248 •
. 249 .
           WINSOW-S3=WINDOW LIKE=WINSOW-S2 EXCEPT W=316 ...
• 250 •
4 251 ★
           RODESGW1=RODE
• 252 •
             CONSECONSROOFSAW SEFEFF1.0 XEO YEO ZE17.3 AZE180

    253 *

             TILT=0 H=50 W=781 G-F-F-0 ...
· 254 ·
* 255 *
           RODES6W2=ROOF LIKE=ROCES6W1 EXCEPT Y=196 ...
• 256 •
• 257 ·
           RODES6W3=ROOF FIKE=RODES6W1 EXCEPT Y=50 H=146 W=50 ...
· 258 ·
• 253 •
           ROOF55W4=ROOF LIKE=ROOF56W3 EXCEPT X=365 ...
• 260 •
• 251 •
           ROOF56W5=ROOF LIKE=ROOF56W3 EXCEPT X=731
• 262 •
           FLOORSSW-F-W
* 263 *
             CONS-CONSELURS6W S-F-F=0 X=0 Y=246 7=0 AZ=180 111 T=180
· 254 ·
• 265 •
             H=246 W=338.8 G-F-F=1.0 ...
• 266 •
• 267 •
                   $ FIFTH A SIXTH FLOOR - EAST $
· 258 ·
· 263 ·
             ZONESEE-SPACE
              X-1008 Y-0 Z=44.6 AZ-0 AREA=95200
· 270 ·
               VOLUME #809200 SPACE - CONDITIONS = CONDS6F ...
• 271 •
• 272 •
· 273 ·
             EWSGE WITE W
               CONS=CONSWINDOW S-F-F=0.5 X=0 Y=246 Z=0 AZ=270
· 274 ·
· 275 ·
               TILI-90 H-17.3 W=246 G-F-F=0.5 ...
• 276 •
             WINSOE-WITHINDOW
• 277 •
               G T-GLAZING X-0 Y-5,92 H-5,466 W-246 S-F-F-0.5
               CONDUCT-SCHEDULE = DRAPESCHED G-F-F-0.5
• 278 •
· 279 ·
             EWSSE-W2=E-W LIKE=EWSSE-W1 FXCEPT X=280 Y=196 W=146
• 200 •
· 281 ·
               S F F-0.42 G F-F-0 58
• 292 •
             WINSER WZ=WINDOW LIKE=WINSEE-W1 EXCEPT W=146 S F-F=0 42
· 207 ·
              G F F -0.58
· 234 ·
· 205 •
             EWSER EITE W LIFFTEWSEE-WO EXCEPT X-50 Y-50 AZ-90
• 285 •
             WIN56E-E1=WINDOW LIKE=WIN56E-W2 EXCEPT Y=3.38 H=10.54 ...
· 287 ·
             EWSRE F2-E-W LIME-EWSRE-WI EXCEPT X-330 Y-0 A7=90
· 208 ·
             WINS6E-E2=WINDOW LIKE=WINS6E-E1 EXCEPT W-246
• 283 •
• 290 •
             FWSGE SITE W LIKETEWSGE-WI EXCEPT YOU AZTING WESSEL
+ 201 +
             WINSEE-S1=WINDOW LIKE=WINSEE-F2 EXCEPT W=330
• 232 •
233 *
             EWSGE-52-E-W EIKE-EWSGE S! EXCEPT Y-50 Y-196 W-220
· 234 •
             WINSGE-S2#WINDOW LIKE-WINSGE ET EXCEPT W-230 S-F-F-0 45
• 225 •
• 296 •
               G-F-F=0.55 ...
· 537 ·
· 208 ·
             TWERE-MITTER TIME-LARGE-25 EACEDT A-SBO A-BO VS-O
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The second section of the second seco

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· 299 ·
             WINSGE-NIEWINDOW LIKEEWINSGE-S2 ...
 * 3(N) *
 . 3 . .
              EWSGE-N2-E-W LIKS-EWSGE-ST EXCEPT X=330 Y=246 AZ=0
 • 302 •
             WINS6E-N2=WINDOW LIKE=WINS6E-S1 ...
 • 303 •
              POOFSEE 1-POOF
 . 20.4
               CONS=CONSRODE56W S-F F=1.0 X=0 Y=0 Z=17.3 AZ=180

    305 *

 . 306 .
               TILT=0 H=50 W=330 G-F-F=0.0
 · 307 ·
              ROOFS6E2=ROOF L.KF=ROOFS6E1 EXCEPT Y=196 ...
 · 308 ·
 · 309 ·
 • 310 •
              ROOF56E3=ROOF LIKE=ROOF56E1 EXCEPT Y=50 H=146 W-50 ...
 • 311 •
 • 312 •
             ROOF56E4=ROOF LIKE=ROOF56E3 EXCEPT X=280 ...
 * 317 *
 · 314 ·
             FLOOP56E=E-W
              CONSECONSFLURS6W S F-F=0 X=0 Y=246 Z=0 AZ=180 IILT=180
 . 7.5 .
 . 315 .
               H=246 W=150.5 G-F-F=1.0 ...
 • 317 •
                   $ SECOND & THIRD FLOORS - WEST $
 . 318 .
 • 319 •
 • 320 •
             ZONE 23W-SPACE
             x=0 Y=0 Z=11 2 AZ=0 AREA=229200 VOLUME=1948200

    321 •

-CAULION-----
-CASTION--- VALUE GREATER THAN MAXIMUM OF 0.1000E+06
-CAUTION--- VALUE GREATER THAN MAXIMUM OF 0.1000E+07
               SPACE-CONDITIONS=COND23W ...
 * 322 *
 · 323 ·
             EW23W-W1=E-W
 • 324 •
               CONS=CONSWINDOW S-F-F=0.5 X=0 Y=246 Z=0 AZ=270
 • 375 •
               TILT=90 H=18 4 W=246 G-F-F=0.5
 • 3, • •
              WIN23W WIRWINDOW
 · 327 ·
               G T=GLAZ1NG X=0 Y=5.92 H=5.466 W=246 S-F-F=0 5
• 328 •
               CONDUCT - SCHEDULE = DRAPESCHED G-F-F=0.5
 · 323 ·
 • 330) •
 · 331 ·
             -EW23W-W2=E-W LIKE=EW23W-W1 EXCEPT X=197 Y=196 S F FTO 28
 * 332 *
               W=146 G F-F=0.72
              WIN73W W2=WINDOW LIKE=WIN23W-W1 EXCEPT W=146 S-F-F-0.28
 · 333 •
 • 334 •
               G-F-F=0.72 ...
 • 335 •
 * 336 *
             EW23W-W3-E-W LIKE=EW23W-W2 EXCEPT X=365 ...
 · 337 ·
              WIN23W-W3=WINDOW LIKE=WIN23W-W2 ...
 · 338 ·
 • 339 •
             EW23W W4=E-W LIKE=EW23H-W2 EXCEPT X=534 ...
 · 340 ·
             WIN23W-W4=WINDOW LIKE=WIN23W-W2 ...
 • 341 •
             EW23W-W5=E-W LIKE-EW23W-W2 EXCEPT X-731
 * 342 *
             WIN23W-W5=WINDOW LIKE=WIN23W-W2 ...
 . 747 .
 . 344 .
 • 345 •
             FW23W-F1=E-W LIKE=EW23W-W2 EXCEPT X-50 - 7-50 AZ=00
             WIN23W-E1=WINDOW LIKE=WIN23W-W2 EXCEPT Y=3.38 H:10 54
 . 246 .
 • 347 •
 • 348 •
             EW23W-E2=E-W LIKE=EW23W-E1 EXCEPT X=247 ...
 • 349 •
              WIN23W-E2=WINDOW LIKE=WIN23W-E1 ...
 • 350 •
             FW23W-E3=E-W LIKE=EW23W-E1 FXCEPT X=415
 • 351 •
             WIN23W-E3=WINDOW LIKE=WIN23W-E1 ...
 • 352 •
 • 353 •
             FW23W-F4+F-W 1 EKF=FW23W-E1 EXCEPT K-584
 · 354 ·
 • 355 •
             WIN23W-E4=WINDOW LIKE=WIN23W-E1 ...
 • 356 •
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```
FW23W-E5-E-W LIKE=EW23W-E1 EXCEPT X-781 ...
• 357 •
             WIN23W-E5=WINDOW LIKE=WIN23W-E1 ...

    358

· 359 ·
             FW23W-N1=E-W EIKE=EW23W-W1 EXCEPT X=781 AZ=0 W=781
• 360 •
· 351 ·
             WIN23W-N1=WINDOW LIKE=WIN23W-W1 EXCEPT Y=3.38 H=10 54
• 362 •
• 363 •
* 364 *
             FW23W-N2=E-W LIKE-EW23W-E1 EXCEPT X-197 Y-50 AZ=0 W-147 ...
• 765 •
             WIN23W-N2=WINDOW LIKE=WIN23W-E1 FXCEP1 W=147 ...
• 356 •
• 357 •
             EW23W N3-E W LIKE-EW23W-N2 EXCEPT X-365 W-120
• 368 •
             WIN23W N3:WINDOW LIKE-WIN23W-N2 EXCEPT W-120
. 260 .
• 370 •
             FW23W-N4=E-W LIKE=EW23W-N3 EXCEPT X=534 W=119 ...
• 371 •
             WIN23W-N4=WINDOW LIKE=WIN23W-N3 EXCEPT W-119 ...
• 372 •
• 373 •
             FW23W-N5=E-W | IKE=EW23W-N4 EXCEPT X=731 W=147 ...
. 774 .
             WIN23W-N5=WINDOW LIKE=WIN23W-N4 EXCEPT W=147 ...
* 375 *
• 376 •
             EW23W-S1=U-W
· 377 ·
              A=14370 CONS=CONSUGW ...
• 37P •
• 379 •
             FW23W 52*E-W LIKE*EW23W-N2 EXCEPT X 50 Y 196 A7* 180
• 560 •
             WIN23W-S2=WINDOW LIKE=WIN23W-N2 ...
. 351 .
             EW23W-S3-E-W LIKE=EW23W-S2 EXCEPT X=247 W=120 ...
· 202 ·
• 393 •
             WIN23W-S3=WINDOW LIKE=WIN23W-N3 ...
· 294 ·
             FW23W-S4-E-W LIKE-EW23W-S2 EXCEPT X=415 W-119 ...
* 325 *
* 356 *
             WIN23W-S4=WINDOW LIKE=WIN23W-N4 ...
* 397 *
• 368 •
             EW23W S5-E-W LIKE-EW23W-S2 EXCEPT X=584 ...
             WIN23W-S5=WINDOW LIKE=WIN23W-N5 ...
· 303 ·
· 330 ·
· 391 ·
             R00F23W1=R00F
• 325 •
               CONSECUNSFLORSON S F-FEO.5 XEO YEO ZE18.4 AZE180 ILLIEO
* 333 *
               H=50 W=781.0 G-F-F=0.5 ...
. 334 .
             ROOF23W2=ROOF LIKE=ROOF23W1 EXCEPT Y=196 W=448.1 ...
• 375 •
. 396 .
             POGF 23W3=ROOF LIKE=ROOF 23W1 EYCEPT Y=50 H=146 W=50 ...
• 337 •
* 308 *
             ROOF23W4=ROOF LIKE ROOF23W3 EXCEPT X=197 ...
• 273 •
* A(N) *
             ROOF23W5=ROOF LIKE=ROOF23W3 EXCEPT X=365
· 401 ·
· 402 ·
             ROOF23W6=ROOF LIKE=ROOF23W3 EXCEPT X=534
· 403 ·
. 404 .
             POOF23W7=ROOF LIKE=ROOF23W3 EXCEPT X=731 ...
· 405 ·

 406

             FLOOR23W=E-W CONS=CONSFLORS6W S-F-F=0 X=0 Y=246
· 407 ·
               Z-Q AZ=180 TILT=180 H=246 W=277.4 G-F F=1.0 ...
· 408 ·
· 403 ·
· 410 ·
                   $ SECOND AND THIRD FLOOR - FAST $
. 411 .
             ZONE 2 RE = SPACE
· 4:2 ·
               X=1009 Y=0 Z=11 2 AZ-0 APEA-95200
· 413 ·
               VOLUME = 809200 SPACE - CONDITIONS - COND27F
· 414 ·
• 415 •
             EW23E-W1-E-W CONS-CONSWINDOW S-F-F-0 28 Y-0
. 415 *
               9-106 Z=0 AZ-270 TILT-99 H-18,4 W-146 G F F-0,72
· 417 ·
             KIN23E-W1=WINDOW G-T-GLAZING XFO YES 92 HT5.466
+ 41B +
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. 419 . W=146 S-F-F=0.28 CONDUCT-SCHEDULE=DRAPESCHED G F F=0.72 ... • 420 • • 421 • EMPOR-Ware willike rewade -will except (+280) · 422 · WIN23E-W2=WINDOW LIKE=WIN23E-W1 ... · 427 · EWZ?E-E1TE-W LIMETEW23E-W1 FXCFRI X:50 Y:50 AZ:90 ... • 424 • · 425 · WIN2DE-E1-WINDOW LIKE-WIN2DF-W1 EYCEPT Y=0.38 H=10.54 • 426 • • 427 • FW23E-521E WILLIKE=EW23E-E1 EXCEPT X=330 Y=0 W=24G · 429 · 5 F F = 0 5 G F - F = 0 5 • 479 • WIN23E-E2-WINDOW LIKE-WIN23E-E1 EXCEPT W-246 S F F=0 5 • 470 • G-F-F-0 5 • 471 • · 432 · E#23E-N1=E-W ! IKE=EW23E-E2 FXCEPT x-330 Y-246 A2-0 W=330 • 433 • WIN23E-N1=WINDUW LIKE=WIN23E-E2 EXCEPT W-030 · 434 · . 475 . FW23E N21E W LIKETEWITE NI FRCERT #1280 Y-50 W-230 • 475 • S-F-F-0 28 G-F-F-0 72 ... · 437 • WIN23E-N2:WINDOW LIKE-WIN23E-E1 FXCEPT W: 230 · 438 · . 472 . EW23E-S1#E-# LIKE#EW23E-N1 EXCEPT X#64 140 AZ#180 · 440 · w=266 441 . WIN23E-51=WINDOW LIKETWIN23E-N1 EXCEPT W=266 • 442 • EW235-\$2:6 W LIKE:6W236-N2 EXCEPT X-50 Y=106 AZ-180 ... • 443 • . 414 . #IN23E-S2=WINDOW LIKE=WIN23E-N2 · 445 · · 445 · RODF23E1=POOF CONS=CONSROOF5GW S-7-F-0.5 X=0 Y=0 . 447 . Z=18.4 AZ=180 T1LT=0 H=50 W=118 6 G F-F=0 5 . 449 . · 449 · #00F23E2*P00F LIKE=#00F23E1 FXCEPT Y=196 W=330 • 450 • . 451 . ROOF23E3=ROOF LIKE=ROOF23E1 EXCEPT Y-50 H-146 W-50 • 452 • • 453 • ROOF23E4=ROOF LIKE=ROUF23E3 EXCEPT X=280 . • 454 • FLCOR23E=E-W CONS=CONSFLORSOW 5-F-F-0 X-0 Y-246 * 455 * · 456 · 2-0 AZ=18D TILT=180 H=246 W=193.5 G F F=1.0 15.7 . 45A . \$ FIRST THRU THIRD FLOORS - SOUTH \$ • 459 • • 450 • ZUNE 235 = SPACE . 45: . 1#764 7#-42 ZTO AZTO AREA#85000 VOLUME#765(NO) · 462 · SPACE-CONDITIONS=COND235 ** 463 · • 454 • FW235-N1=F-W CONS=CONS2351 x=308 y=92 Z=0 AZ=0 T111=90 H=11.3 W=208 S-F-F=0 25 G-F-F=0 75 465 . • 466 • • 457 • F#23S-N2=E W CONS=CONSWINDOW x-244 v-02 Z-11 3 AZ O · 468 · TILI=90 H-18,4 W=227 S-F-F-0 25 G F-F-0 75 . 459 . #IN235-N2=WINDOW G-T=GLAZING X-0 x-3 38 H-10 54 W-227 • 470 • S-F-F+0.4 G-F-F+0.6 CONDUCT SCHEDULE - DRAPESCHED • 171 • • 472 • EW235-W1=E:W CONS=CONS2351 X=0 x=92 Z=0 AZ=270 11111-90 H=11 3 · 4/3 · #=92 S-F-F=G.2 G-F-F=0.8 . . 4:4 . • 475 • FWC35 W2=E-W CONSECONS2351 AEO 7E42 ZE11 2 HE18 A WEAR . 4 6 . AZ=270 TILT=90 S-F-F=0 35 G F-F=0 65 · 477 · · 4/8 · EW235-51=E-W | CONS=COMS2351 fro iro Zro AZ=180 [[111 90 • 473 • H-29.7 W-108 S-F-F-0 5 G F-F-0 5 · 480 ·

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. 401 .
              EW235 Ei=F-W | CONSTCONS2351 X-308 M-0 7-0 AZ=90 TILT=20
  * 482 *
               H-11.3 W=92 S-F-F=0.2 G-F-F=0 R
  · 423 ·
  • 48A •
              EW735-E2=E W CONS-CONS23S1 X-308 Y-0 7-11 3 A7-90 1111-90
  · 485 ·
               H=18 4 W-42 5-F-F=0,35 G F-F=0.65
 * 486 *
 • AP7 •
              FLOOR235#U-F AREA=800 CONS=CONSUGW
  · 405 ·
 • 487 •
              RD0F235-RD0F
  · 430 ·
               CONSTCONSPOOR 56% S F FT0.75 XT0 XT0 Z-29 7 47-180
 + A31 +
                TH T=0 H=92 M=264 G-F-F=0.25
 . 472 .
 • 433 •
              IW235-235=1-W
 * 494 *
                AREA=2097 6 CONSTRUCTION-IWALL NEXT-TO-ZONE23F ...
 * 435 *
 * 475 *
              IW235-23W-I-#
 • 497 •
                AREA=1233 CONSTRUCTION=IWALL NEXT-10-70NF23W
 • 439 •
 • 433 •
                    $ SECOND AND THIRD FLOORS - NORTH $
 · 500 ·
 • 5g • •
            ZONE 2 THE SPACE
 · 5/17 ·
             - 1-791 1-196 7-11.2 AZ-O APEA=28229 VOLUME=253769
 • 507 •
              SPACE-CONDITIONS-COND23N
 · 504 ·
 • 505 •
            EWOON NITE-WILLENNSHOONSWINDOW S. F-E-O. S. X-227, X-50, Z-O.
 · 506 ·
             AZ-0 TELT=90 H-18 4 W-227 G-F-F-0 5
 * 5x 7 *
            WIN23N-N1-WINDOW G-T-GLAZING Y-0 Y-3 38 16-10 4 W-227
 • 50.8 •
             S-F F=0 50 CONQUET-SCHEDULE-DRAFFSCHED G-F F=0 5
 · 103 ·
 · 4.9 ·
            EWOON STEEN LIKE-EWOON-NT EXCEPT X-0 Y-0 AZ-180
 . 511 .
            WINDOW-SI-WINDOW LIKE:WINZON-NI EXCEPT S-F-F-0.28
 + 512 +
              G-F-F+0.72
 . - 17 .
 + 5'4 ·
            ROOF 23N-ROOF CONS-CONSPOOR 5NW SHE-FIRD, 7 YEAR YEAR ZIELS 4
 • 515 •
             AZ=190 TILT=0 H=50 W-227 G-F-F-0 3
 . 5.6 .
  . 512 -
            FEODPORATE # 1 CONSTIDENT ORSOW S FIFTO XTO XTSO ZTO
 + 5 ta +
             AZ-180 TILT-180 H=50 W=95 2 G-F-F-1 0
 · King ·
 • 520 •
            FW234 N2FF-W COUS-CONSWINDOW S 7-F-0 1 Y-214 G +-41 3 Z- 11
 . . . .
             A7 O TILT-90 H=11 W=200,2 G-F-F=0 9
 • 522 •
            WIN29N N2-WINDOW G T-GLAZING Y-0 +=2,5 H-6 #:202 2 S F F-0 1
 . 573 .
             CONDUCT-SCHEDULE : DRAPESCHED G-F-F-0 9
 • 524 •
 • 525 •
            EW23N (2TE-W) LIKE=EW23N/N2 EXCEPT XT12 4 YE8 7 AZT180
  • 575 •
            WIND IN SERVINORY LIKE-WINESH NO.
 • 527 •
            FWOON FORE WILLING-EWOON NO FXCEPT (-P 7 A7-90 W-32 A
 • 579 •
            WIN23N-E2=WITTOW LIKE=WIN23N N2 EXCEPT W:32 6
 • 52a •
  . 530 .
  • 53t •
            FW23% W2-E-W FIKE-EW25N-E2 EXCEPT X-12 4 Y=41.3 AZ-270
  • 632 •
            WINDOW LIKE-WINZON-EZ
 • 517 •
            FURNEZPHIZED F AREA-5529 DOMS-KOMONOW

    574 •

• 535 •
 . 575 .
            IM274-236-1-W
 • c.; • •
             APPAIRATION CONSTRUCTION TWALL NEXT TO FROM 23F
            [#2 19 27W-] W
 • r, np •
             AREA-920 CONSTRUCTION-IWALL NEXT TO-JONESIW
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у конфентуроф у

. 549 .

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• * 42 • • = • ZONE 4-SPACE . - 44 . - + - - - - Z-3+ - AZ-0 AREA-27217 VOLUME-408255 • 545 • SPACE-CONDITIONS-COND4 • 546 • • 5: 1 • Eat Wille • : := • AZ=1 TILT=00 H=14 W=731 Gof F=0 75 . 544 . • 55 , • william tetrmitals se-- 9 THOUAZINGS - XHO 4H2 57 HHY O WHIRL S F FHO 25 65. G F F F TO TE 655 → . . . • 6:5 • with4 StruithCOd LIKETWIN4 51 · EEE · Fet mitterm (E) FEF (Fe4 Nt ExcEP) x-50 A7-211 W-29 7 . 55 . WIN4-WITHINDOW LIKE #WIN4-NI EXCEPT WE29 7 558 * • 553 • · King · Fact Fire a Livers in at EXCEPT XF781 YF205 2 AZF9) • 55 • • wit-4-Et=winDGw LikE=win4-wt · *** • Emt 52-5 w CIME-Fed 51 ExcEPT x-39 9 x1-53 8 w 29 7 • 500 • . 564 . #184-82=#INDO# LIKE=#IN4 #1 • 565 • • Fig. • FALL SATE WILLIAM THE FRANCING ENGERT X=10 2 YES AZTINO • E. s. * • with a Sommitte Like-with No. • 50B • F#1 #2-F # . [HF-FW4-#1 F#0FP] #-10 7 +-153 8 W-103 8 . 551 . • 571 • wind wirelnion likerwindows except writts A . . . 5 . Fat Fire S : [FETEN4:W2 EXCEPT FT39 9 FT50 AZT9) with4 - E2 = #INCOW LIKE = WIN4 - W2 . 5.11 . • 5 14 • . 5 5 . FAR NOTE # LIKETENA NA EXCEPT AT1255 5 WT157 5 win4-N3-Window Like-Win4-N2 Except W=197 5 • 5.6 • . 5 . . Eat Castia (Interfatel) FreED (**1058 AZETAO FEZOS 2 • 6°8 • • 5 3 • win4-33=winDOw LIKE=#IN4-N3 • 595 • Eat with willetteatest Except Katoss • 581 • · raj · wind wardincom LIKE adina wi • *= 3 • . 524 . FAS FRE W LIME-FWA-ES FATERS 4-1255 5 . 595 . wit4.E3=WINDOW LIKE=win4-E1 . 525 . Fat Nith For 1386-884-N3 EXTERT X-1047 9 Y-196 N-23 7 • 5a * • . 545 . mina-N4=WINDOw LIKE-mIN4-W3 · 599 · Fa4 54=F m / [*E-F#4-N4 EXCEPT X-1018 2 +-5 AZ-190 • 590 • • 531 • wiha-Sarwindow Likerwina-N4 • 557 • Ead ad=E-W LIKE=Ead-w3 ExCEPT x=1919 2 x=196 W=146 . 553 . • 554 • win4 w4=window Like=win4-w3 ExCEPT wilde • 535 • Fed F4-F/m Lime-Fad #4 Except x=1047 9 x=50 47 90 • 542 · . 557 . wina-Farmincow Likerwina-wa • 519 • FM4 NT-F W (IME-FM4 NA EXCEPT M-1327 9 . : : : wih4-N5=wiNDOw LixE=wiN4 N4 • 607 • Fed 55-F-W ([MF=Fe4 54 EXCEPT X=1208] . 603 . wind-SS-windSa Limf-wind-St

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· Era V
             Fud WEST # LIMESEWA-WA EXCEPT TE1298 2
   . 605 .
              WINA WE WINDOW LIKETWINA-WA
   . . .
   • 605 •
             ENA FS-E WILLIEFFWA FA EXCEPT Y-1327 9
   . . . .
              WIN4 FROMINDOW LIKE THIN4 E4
   . E/3 .
   · r · n ·
   . . . .
              [M4 27W-1-W
              AREA-16647 CONSTRUCTION-IWALL NEXT TO-ZONE 23W
   * 617 *
   . . . .
              [#1 568-] W
   · 614 ·
              AREA-16647 CONSTRUCTION-IWALL NEXT TO-ZONESEW
   • 5 • 5 •
   . FIE .
   . . . .
              I₩4 275-1 ₩
              APFA-19570 CONSTRUCTION: IWALL NEXT TO: 704E23E
   . 6.2 .
   . 615 .
              IW4 SEE-I W
   • 620 •
              AREA-10570 CONSTRUCTION-IWALL NEXT-TO-ZONESGE
   · 62 · ·
   · F:2 .
   • F73 •
                     1 REPORTS 1
   · 574 ·
             LUADS REFORT
   . 675 .
              VEDICICATION-CALL VERIFICATION)
   • 676 •
               SUMMARY-(ALL-SIJMMARY)
   * r; * *
   • F39 •
             für dise-mergmi minok
   • 633 •
              WARTAR FATHER GURRAL
   . ESG .
              WARIAR_E-LIST-13,4,13,16) ...
   . . . .
   • 677 •
             LDS - ZONESSMEREFORT BLOCK
   . 6:5 .
              VARIABLE-TYPE-ZONESEW
50
              VARIABLE-LIST=(18.19.20.33.37.42.44)
   . . . .
             LDS ZOWEFOR FREDORE BLOCK
   • fif •
              ARTARIA TARE ZONESEE
   . 611 .
   . . . .
              WAREAPER-LIST-(18, 19, 20, 33, 37, 42, 44)
   . E73 .
   • £41) •
             The put-Modal a behous
              TARREST STOURT ELECTRINATACHED
   . 541 .
                BELOCK - HIDS-GLOP, LDS-ZONESEW, LDS-ZONESEE)
   . FA2 .
   . EA7 .
   • 514 • FM
   . S45 . COMPUTE LOADS
   * 615 * 54.F-FILES ...
   • 54" • 5"CP ...
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67 .	CONVERTIONS DEANT ASSESSMENT DEANT GERBRE SSYMMARY SKESSMMARY E		
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LDL PROCESSOR INPUT DATA 82/09/29. 08:40:25. LDL RUN 1

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2 . DIAGNOSTIC CAUTIONS ...
    3 . ABORT ERRORS ...
    5 •
         $ BASELINE BUILDING $
        TITLE = LINE - 1 = +US AIR FORCE ACADEMY +
    A .
    9 •
               LINE-2=*COLORADO SPRINGS*
   10 *
               LINE-3= *FIELD HOUSE EC STUDY *
   11 .
               LINE-4=*B. DAVIS/WX-4/LANL* ..
   12 •
         RUN-PERIOD JAN 1 1978 THRU DEC 31 1978 ...
   :3 •
   14 .
   15 •
         BUILDING-LOCATION
   16 .
               LATITUDE=39 LONGITUDE=105 ALTITUDE=7065
               TIME-ZONE=7 AZIMUTH=0 ..
   17 .
   18 .
   19 •
         BUILDING-SHADE
  20 +
               HEIGHT=450 WIDTH=420 X=-12 Y=-12
               Z=59.9 AZ=180 TILT=0 ..
  21 •
  22 •
  23 . LAW1=LAYERS
                       MATERIAL=(CC25, IN23) ...
  24 . LAW2=LAYERS
                       MATERIAL=(CCO7, IN23) ...
   25 •
        LAW3=LAYERS
                       MATERIAL=(CCO7,GPO3) ...
   26 •
   27 * LAR1=LAYERS MATERIAL=(RG01,BP01,BR01,IN75,IN22) ...
  7R +
  29 • CW1=CONSTRUCTION
                           LA=LAW1 ABS=.65 RO=3 ...
  30 . CW2=CONSTRUCTION
                           LA=LAW2 ABS=.65 RO=3 ..
  31 • CW3=CONSTRUCTION
                           LA=LAW3 ABS=.65 RO=3 ...
                           LA=LAR1 ABS=.29 RO=1 ...
  32 • CR1=CONSTRUCTION
   33 • CUM=CONSTRUCTION
                           U=.10 ..
   34 • CUF = CONSTRUCTION
                           U=.10 ..
   35 •
         CIW1=CONSTRUCTION U=.32 ...
   36 • CIW2=CONSTRUCTION U=2.0 ...
  37 •
  38 * GLT=GLASS-TYPE PANES=1 G-T-C=7 ...
  39 •
                     $ LIGHTING SCHEDULE $
  40 •
  41 .
  42 . LS1=SCHEDULE THRU MAY 20 (ALL)(1,5)(.1)(6,21)(.9)(22,24)( 1)
  43 .
                      THRU SEP 1 (ALL)(1.5)(.1)(6.21)(.5)(22.24)(.1)
  44 .
                      THRU DEC 31 (ALL)(1,5)(.1)(6,21)(.9)(22,24)(.1) ...
  45 .
                    $ PEOPLE SCHEDULES $
  46 *
  47 .

    48 * $ BASKETBALL STADIUM $

• 49 •
  50 * WBS:=WEEK-SCHEDULE (MON, THU)(1, 18)(0)(19,22)(.6)(23,24)(0)
                            (FRI)(1,24)(0)
  51 •
                            {WEH){1,24}(0) ...
• 52 •
  53 •
  54 * WB52*WEEK-SCHEDULE (MON)(1,24)(0)
                            (TUE, WED)(1.18)(0)(19,22)(.6)(23,24)(0)
  55 •
                            (THU_FRI){1,24)(0)
· 55 •
• 57 •
                            (WEH)(1.24)(0) ...
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THRU NOV 1 WBS2
    60 •
                      THRU DEC 31 WBS1 ...
    61 .
    62 . S HOCKEY ARENA S
    63 •
         WHS1=WEEK-SCHEDULE (HON. THU)(1.24)(0)
    64 •
                            (FRI, SUN)(1,18)(0)(19,22)(.6)(23,24)(0)
    55 .
                            (HOL)(1,24)(0) ...
    66 •
    67 .
    68 * WHS2=WEEK-SCHEDULE (MON.THU)(1.24)(0)
                            (FRI_SAT)(1.18)(0)(19.20)(.6)(21.24)(0)
    69 •
    70 •
                            (SUN, HOL)(1,24)(0) ...
   71 •
         HS1=SCHEDULE THRU FEB 20 WHS1
    72 •
                      THRU NOV 1 WHS2
    73 •
    74 .
                      THRU DEC 31 WHS1 ...
    75 •
    76 . $ MULTI-PURPOSE AREA $
    77 .
         WWPS1=WEEK-SCHEDULE (WD)(1,24)(3)
    78 •
                             (WE)(1,12)(0)(13,18)(.6)(19,2¢)(0)
    79 •
                             (HOL)(1,24)(0) ...
    80 .
    81 .
    82 •
          WMPS2=WEEK-SCHEDULE (WD)(1,24)(0)
                             (SAT)(1,12)(0)(13,16)(.6)(17,24)(0)
    B3 •
    84 .
                             (SUN_HOL)(1,24)(0) ...
    85 .
    86 . MPS1*SCHEDULE THPU FEB 20 WMPS1
    87 •
                       THRU NOV 1 WMPS2
                       THRU DEC 31 WMPS1 ...
    * 88
    89 •
                     $ SOURCE SCHEDULE - HOCKEY $
    90 •
    91 •
    92 • RINK1=SCHEDULE THRU DEC 31 (ALL) (1,24) (1) ...
    93 •
    94 •
                     $ SPACE CONDITIONS $
    95 •
    96 •
          SCBBALL=SPACE-CONDITIONS
    97 *
                 T=(68) P-SCH=BS1 N-0-P=6000 P-H-G=450
    98 *
    99 •
                 L-SCH=LS1 L-T=INCAND L-KW=107.42
                 I-M=AIR-CHANGE A-C=.58 Z-TYPE=CONDITIONED ...
 · 100 ·
 · 101 ·
 • 102 •
         SCHOCKEY=SPACE-CONDITIONS
                  T=(68) P-SCH=HS1 N-0-P=4400 P-H-G=450
 • 103 •
                  L-SCH=LS1 L-T=INCAND L-KW=74.4
 • 104 •
                  SOURCE-SCHEDULE *RINK! SOURCE-BTU/HR=-154700
 · 105 ·
                  I-M=AIR-CHANGE A-C=.58 Z-TYPE=CONDITIONED ...
 • 106 •
 · 107 ·
 . 108 . SCMP=SPACE-CONDITIONS
              T=(68) P-SCH=MPS1 N-0-P=1200 P-H-G=450
 · 109 ·
              L-SCH=LS1 L-T=INCAND L-KW=137.52
 . 110 .
               I-M=AIR-CHANGE A-C=.58 Z-TYPE=CONDITIONED ..
 . 111 .
 . 112 .
                     $ BASKETBALL STADIUM - WALLS, ROOF, FLOOR $
 • 113 •
 · 114 ·
 . 115 . DIAGNOSTIC NO-LIMITS ...
 • 116 •
 . 117 . BASKETBALL-SPACE
                    X=O Y=O Z=O AZIMUTH=O AREA=47124
 • 118 •
                    VOLUME=2780316 SPACE-CONDITIONS=SCEBALL ...
 • 119 •
-CAUTION--- VALUE GREATER THAN MAXIMUM OF . 1000E+07
```

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· 120 ·
  . 121 . B-SW1=EXTERIOR-WALL
  • 122 •
                CONSTRUCTION=CW3 X=0 Y=0 Z=0 HEIGHT=13.2
  • 123 •
                WIDTH=198 AZIMUTH=180 TILT=90 ...
  • 124 •
  . 125 . B-SW2=EXTERIOR-WALL
  • 126 •
                CONSTRUCTION=CW1 X=0 Y=0 Z=13.2 HEIGHT=38.8
  • 127 •
                WIDTH=198 AZIMUTH=180 TILT=90 ...
  · 128 ·
  • 129 •
             B-SG1=WINDOW
  • 130 •
                   GLASS-TYPE=GLT X=0 Y=0
  • 131 •
                   HEIGHT=7.25 WIDTH=158 ..
  • 132 •
  · 133 ·
             B-SG2=WINDOW
  - 134 •
                   GLASS-TYPE=GLT >= 158 Y=0
  • 135 •
                   HEIGHT=38.8 WIDTH=40 ...
  • 136 •
  . 137 . B-SW3=EXTERIOR-WALL
  • 138 •
                CONSTRUCTION=CW1 X=0 Y=0 Z=52.0 HEIGHT=8
                WIDTH=198 AZIMUTH=180 TILT=90 ...
  • 139 •
 • 140 •
  . 14: * B-WY!*EXTERIOR-WALL
  • 142 •
                CONSTRUCTION=CW3 X=0 Y=238 Z=0 HEIGHT=13.2
  • 143 •
                WIDTH=238 AZIMUTH=270 TILT=90 ...
  . 144 .
  . 145 . B-WW2=EXTERIOR-WALL
  • 146 •
                CONSTRUCTION=CW1 X=C Y=238 Z=13_2 HEIGHT=38.8
                WIDTH=238 AZIMUTH=27G TILT=90 ...
 • 147 •
 · 148 ·
  . 149 . B-WW3=EXTERIOR-WALL
                CONSTRUCTION=CW1 X=0 Y=238 Z=52.0 HEIGHT=8
 • 150 •
                WIDTH=238 AZIMUTH=270 TILT=90 ...
 • 151 •
  • 152 •
  . 153 . B-R1=ROOF
               CONSTRUCTION=CR1 X=0 Y=0 Z=60.0 HEIGHT+238
  • 154 •
               WIDTH= 198 AZIMUTH= 180 TILT=0 ...
  • 155 •
  · 156 ·
 . 157 . B-U1=UNDERGROUND-FLOOR
               AREA=47124 CONSTRUCTION=CUF ...
 • 158 •
  · 159 ·
                      $ HO.KEY ARENA - WALLS.POOF, FLOOR $
 • 160 •
 • 161 •
 . 162 . HOCKEY=SPACE
                X='98 Y=0 Z=0 AZIMUTH=0 AREA=47124
 • 163 •
                 VOLUME * 2780316 SPACE - CONDITIONS = SCHOCKEY ...
 • 164 •
-CAUTION-----
-CAUTION--- VALUE GREATER THAN MAXIMUM OF
                                         . 1000E+07
 • 165 •
 . 166 . H-SW1=EXTERIOR-WALL
 • 167 •
                CONSTRUCTION=CW3 X=0 Y=0 Z=0 HEIGHT=13.2
                WIDTH=198 AZIMUTH=180 TILT=90 ...
 · 168 ·
 • 169 •
 . 170 . H-SW2=EXTERIOR-WALL
 • 171 •
                CONSTRUCTION=CW1 X=0 Y=0 Z=13.2 REIGHT=38.8
                WIDTH=198 AZIMUTH=180 TILT=90 ...
 · 172 ·
 173 ·
 · 174 ·
             H-SG1=WINDOW
                   GLASS-TYPE=GLT X=0 Y=0
 • 175 •
                   HEIGHT=38.8 WIDTH=40 ..
 · 176 ·
 • 177 •
             H-SG2=WINDOW
 · 178 ·
                   GLASS-TYPE=GLT X=40 Y+0
 · 179 ·
                   HEIGHT = 7.35 WIDTH = 158 ...
 . 180 .
 . 181 .
```

```
CONSTRUCTION*CWT X=0 Y=0 Z=52.0 HEIGHT=8
 · 184 ·
               WIDTH=198 AZIMUTH=180 TILT=90 ...
 • 185 •
 . 186 . H-EW1=EXTERIOR-WALL
 • 187 •
               CONSTRUCTION=CW3 X=198 Y=0 Z=0 HEIGHT=13.2
 - 188 -
               WIDTH=238 AZIMUTH=90 TILT=90 ..
 · 189 •
 . 190 . H-EW2=EXTERIOR-WALL
               CONSTRUCTION=CW1 X=198 Y=0 Z=13.2 HEIGHT=38.8
 • 191 •
 • 192 •
               WIDTH=238 AZIMUTH=90 TILT=90 ..
 • 193 •
 . 194 . H-EW3=EXTERIOR-WALL
               CONSTRUCTION=CW1 X=198 Y=0 Z=52.0 HEIGHT=8
 • 195 •
 • 196 •
               WIDTH=238 AZIMUTH=90 TILT=90 ...
 • 197 •
 • 198 • H-R1=ROOF
 . 199 .
              CONSTRUCTION=CR1 X=0 Y=0 Z=60.0 HEIGHT=238
 • 200 •
              WIDTH= 198 AZIMUTH= 180 TILT=0 ...
 • 201 •
 * 202 * H-U1=UNDERGROUND-FLOOR
 • 203 •
              AREA=47124 CONSTRUCTION=CUF ...
 • 204 •
 . 205 . H-IW1=INTERIOR-WALL
 • 206 •
               AREA=11140 CONSTRUCTION=CIW2 NEXT-TO=BASKETBALL ...
 * 207 *
 * 208 *
                     $ MULTI-PURPOSE AREA - WALLS, ROOF, FLOOR $
 • 209 •
 * 210 * MULTI-PURPOSE*SPACE
 • 211 •
                     X=0 Y=238 Z=0 AZIMUTH=0 AREA=74448
 • 212 •
                      VOLUME=5732496 SPACE-CONDITIONS=SCMP ...
-CAUTION--- VALUE GREATER THAN MAXIMUM OF . 1000E+07
 • 213 •
 . 214 . MP-NW1=EXTERIOR-WALL
 • 215 •
                CONSTRUCTION=CW2 7=396 Y=188 Z=0 HEIGHT=13.2
 * 216 *
                WIDTH=396 AZIMUTH=0 TILT=90 ..
 • 217 ·
 . 218 . MP-NW2=EXTERIOR-WALL
 • 219 •
                CONSTRUCTION=CW1 X=396 Y=188 Z=13.2 HEIGHT=38.8
                WIDTH=396 AZIMUTH=0 TILT=90 ..
 • 220 •
 • 221 •
 * 222 * MP-NW3=EXTERIOR-WALL
                CONSTRUCTION=CW1 X=396 Y=188 Z=52.0 HEIGHT=8
 * 223 *
 • 224 •
                WIDTH=396 AZIMUTH=0 TILT=90 ...
 • 225 •
 . 226 . MP-WW1=EXTERIOR-WALL
 • 227 •
               CONSTRUCTION=CW2 X=0 Y=188 Z=0 HEIGHT=13.2
                WIOTH=188 AZIMUTH=270 TILT=90 ...
 • 228 •
 • 229 •
 . 230 . MP-WW2=EXTERIOR-WALL
 231 *
                CONSTRUCTION=CW1 X=0 Y=188 Z=13.2 HEIGHT=38.8
 • 232 •
                WIDTH=188 AZIMUTH=270 TILT=90 ...
 • 233 •
 • 234 • MP-WW3=EXTERIOR-WALL
 • 235 •
                CONSTRUCTION=CW1 X=0 Y=188 Z=52.0 HEIGHT=8
 · 236 ·
                WIDTH=188 AZIMUTH=270 TILT=90 ...
 • 237 •
 . 238 . WP-EW1=EXTERIOR-WALL
 • 239 •
               CONSTRUCTION=CW2 X=396 Y=0 Z=0 HEIGHT=13.2
 • 240 •
               WIDTH=188 AZIMUTH=90 TILT=90 ..
 • 241 •
 . 242 . MP-EW2=EXTERIOR-WALL
               CONSTRUCTION=CW1 X=396 Y=0 Z=13.2 HEIGHT=38.8
 · 243 ·
```

```
WIDTH=188 AZIKUTH=90 TILT=90 ...
• 244 •
• 245 •
. 246 . MP-EW3=EXTERIOR-WALL
               CONSTRUCTION=CW1 X=396 Y=0 Z=52.0 HEIGHT=8
• 247 •
               WIDTH=188 AZIMUTH=90 TILT=90 ...
• 248 •
• 249 •
. 250 . MP-R1=R00F
              CONSTRUCTION=CR1 X=0 Y=0 Z=60.0 HEIGHT=188
• 251 •
              .. OFTLIT OBTEHTUMISA SECENTION
• 252 •
· 253 ·
• 254 • MP-U1=UNDERGROUND-FLOOR
              AREA=74448 CONSTRUCTION=CUF ...
• 255 • ·
• 256 •
. 257 . MP-IW1=INTERIOR-WALL
               AREA=11880 CONSTRUCTION=CIW1 NEXT-TO=BASKETBALL ...
• 258 •
• 259 •
. 260 . MP-IW2=INTERIOR-WALL
               AREA=11880 CONSTRUCTION=CIW1 NEXT-TO=HOCKEY
• 261 •
• 262 •
. 263 . LOADS-REPORT
              VERIFICATION=(ALL-VERIFICATION)
· 264 ·
• 265 •
              SUMMARY=(ALL-SUMMARY) ...
· 265 ·
• 267 • HW1=SCHEDULE THRU DEC 31 (ALL)(1.24)(1) ...
• 268 •
• 269 • BUILDING-RESOURCE
              HW-SCHEDULE +HW1 HOT WATER=65000 ...
• 270 •
• 271 •
• 272 •
• 273 • END ...
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• 274 • COMPUTE LOADS ..
• 275 •
• 276 •
• 277 • INPUT SYSTEMS ..
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SDL PROCESSOR INFUT DATA 82/09/29. 08:40:25, SDL RUN 1

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• 278 •
· 279 ·
                     $ SCHEDULES $
· 280 ·
• 281 • BB-HB=SCHEDULE HRU DEC 31 (ALL) (1,24) (70)
• 282 •
• 283 •

    284 • BB-MASW1=WEEK-SCHEDULE (MON, THU)(1,18)(0)(19.22)(1)(23.24)(C)

                                 (FRI)(1,24)(0)
· 285 ·
                                 (WEH)(1,24)(O) ...
• 286 •
• 287 •
• 288 • BB-MASW2*WEEK-SCHEDULE (MON)(1,24)(0)
                                 (TUE, WED)(1, 18)(0)(19,22)(1)(23.24)(0)
· 289 ·
• 290 •
                                 (THU, FRI)(1,24)(0)
• 291 •
                                 (WEH)(1,24)(0) ...
• 292 •
. 293 . BB-MAS=SCHEDULE THRU FEB 20 BB-MASW1
                          THRU NOV 1 BB-MASW2
• 294 •
                          THRU DEC 31 BB-MASW1 ...
• 295 •
• 296 •
• 297 •
* 298 * H-HTS*SCHEDULE THRU DEC 31 (ALL)(1,24)(62) ...
· 299 ·
· 300 ·
• 301 • H-MASW1=WEEK-SCHEDULE (MON.THU)(1,24)(0)
                                (FRI, SUN)(1, 18)(0)(19, 22)(1)(23.24)(0)
• 302 •
• 303 •
                                (HOL)(1,24)(0) ...
· 304 ·
* 305 * H-MASW2=WEEK-SCHEDULE (MON. THU)(1,24)(0)
                               (FRI.SAT)(1.18)(0)(19.20)(1)(21.24)(0)
• 306 •
• 307 •
                                (SUN, HDL)(1,24)(0) ...
· 308 ·
. 309 . H-MAS=SCHEDULE THRU FEB 20 H-MASW1
                         THRU NOV 1 H-MASW2
• 310 •
· 311 ·
                         THRU DEC 3: H-MASW1 ...
· 312 ·
• 313 •
* 314 * MP-HTS*SCHEDULE THRU DEC 31 (ALL)(1,24)(65) ...
• 315 •
* 316 * MP-MASW1=WEEK-SCHEDULE (90)(1,24)(0)
                                 (WE)(1,12)(0)(13,18)(1)(19,24)(0)
• 317 •
· 318 ·
                                 (HOL)(1,24)(0) ...
· 319 ·
• 320 • MP-MASW2=WEEK-SCHEDULE (WD)(1,24)(0)
                                 (SAT)(1,12)(0)(13,16)(1)(17.24)(0)
• 321 •
• 322 •
                                 (SUN, HCL)(1,24)(0) ...
• 323 •
. 324 . MP-MAS*SCHEDULE THRU FEB 20 MP-MASW1
• 325 •
                         THRU NOV 1 MP-MASW2
• 326 •
                         THRU DEC 31 MF-MASW1 ..
• 327 •
• 328 •
. 329 . HOT-DAY1-DAY-RESET-SCH
                  SUPPLY-H1=120 SUPPLY-L0=60
• 330 •
• 331 •
                  OUTSIDE-HI=70 OUTSIDE-LO=0 ...
• 332 •
• 333 • HOT-RESET1=RESET-SCHEDULE THRU DEC 31 (ALL) HOT-DAY! ...
```

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• 334 •
 * 335 * COOL-SCH1=SCHEDULE THRU DEC 31 (ALL)(1,24)(0) ...
 • 335 •
 • 337 •
                    $ BASKETBALL AREA $
 • 338 •
 • 379 •
          BASKETBALL=ZONE
 • 240 •
                     DESIGN-HEAT-T=70 HEAT-TEMP-SCH-88-HB
 • 341 •
                     DESIGN-COOL-T=80 ZONE-TYPE=CONDITIONED ...
 · 342 ·
 . 343 . BB-C. ITROL=SYSTEM-CONTROL
 • 344 •
                     MAX-SUPPLY-T=120 MIN-SUPPLY-T=60
 • 345 •
                    COOLING - SCHEDULE = COOL - SCHI
 • 346 •
                     HEAT-CONTROL=RESET HEAT-RESET-SCH=HOT-RESET1
 · 347 ·
                     COOL-SET-T+60 ECONO-LIMIT-T+75 ...
 • 348 •
 . 343 . BB-AIR=SYSTEM-AIR
 • 350 •
                 MIN-AIR-SCH=BB-MAS OA-CONTROL=TEMP ...
 • 351 •
 . 352 . 88-FANS=SYSTEM-FANS
 • 353 •
                 FAN-SCHEDULE-88-MAS FAN-CONTROL-SPEED
 • 354 •
                 SUPPLY-KW+.00032
 • 355 •
                 NIGHT-CYCLE-CTRL=CYCLE-ON-ANY ...
 • 356 •
 . 357 . BB-SYS*SYSTEM
                 SYSTEM-TYPE-MZS ZONE-NAMES=(BASKETPALL)
 • 359 •
 • 359 •
                 SYSTEM-CONTROL+88-CONTROL SYSTEM-AIR-88-AIR
 • 350 •
                 SYSTEM-FANS-BB-FANS ...
 • .51 •
 • 352 •
                    S HOCKEY ARENA $
 • 767 •
 . 344 . HOCKEY=ZONE
                 DESIGN-HEAT-T-62 HEAT-TEMP-SCH-H HTS
 • 355 •
 • 755 •
                 DESIGN-COOL-T#80 ZONE-TYPE*CONDITIONED ...
 • 357 •
 . 369 . H-CONTROL+SYSTEM CONTROL
                    MAX-SUPPLY-T-120 MIN-SUPPLY-T-50
 • 363 •
 · 770 ·
                    HEAT CONTROL PRESET HEAT-RESET SCH-HOT-RESET!
                    COOLING-SCHEDULE + COOL - SCHI
 • 371 •
 • 372 •
                    COOL-SET-T#40 ECONG-LIMIT-T#75
-CAUTION - -- VALUE NOT BETWEEN
                                 45 0000 AND
                                                   70 0000
 . 373 .
 * J74 * H-AIR+SYSTEM-AIR
                WIN-AIR-SCH-H-MAS DA-CONTROL-TEMP
 • 7'5 •
 . 775 .
 • 37 •
         H-FANS+SISTEM-FANS
                 FAN-SCHEDULE-H-MAS FAN-CONTROL+SPEED
 · 378 ·
                 SUPPLY-KW+ 00232
 • 779 •
 • 380 •
                 NIGHT-CYCLE-CIRL=CYCLE-ON-ANY
 . 791 .
 . 342 . H-SYS+SYSTEM
                SYSTEM-TYPE-MZS ZONE-NAMES*(HDCKEY)
 . 747 .
 . 184 ·
                SYSTEM-CONTROL - H-CONTROL SYSTEM-AIR - H AIR
 . 205 .
                SYSTEM-FANS H-FANS ...
 . 705 .
                    $ MULTI-PURPOSE AREA $
 . 197 .
 • 366 •

    283 ◆ MULTI-PURPOSE *70*IE

                        DESIGN HEAT-T-65 HEAT TEMP SCHEMPING
 • 170 •
                        DESIGN-COOL-T+80 ZONE-TYPE+CONDITIONED .
 . 371 .
 • 372 •
 . 333 . MP-CONTROL-SYSTEM-CONTROL
                    MAY-SUPPLY-1+170 MIN SUPPLY-1-CO
 • 394 •
                    HEAT-CONTROL+RESET HEAT-RESET SCH-HOT-RESETT
 • 395 •
```

```
COOLING-SCHEDULE - COOL - SCHIL
• 335 •
                    COCL-SET-T+60 ECONO-LIMIT-T
• ,37 •
• 348 •
. 333 . MP-AIR=SISTEM-AIR
                MIN-AIR-SCH-MP-MAS GA-CONTROL-TEMP
• 420 •
• 401 •
. 402 . MP-FANS-SYSTEM FANS
                 FAN-SCHEDULE - MP - MAS FAN-CONTROL - SPEED
• 403 •
. 404 .
                 SUPPLY KW+.00032
                 NIGHT-CYCLE-CTRL+C/CLE-DN-AN/
• 425 •
• 406 •
. 407 . MP-SYSESYSTEM
                SYSTEM-TYPE-MZS ZONE NAMES-(MILLIT PURPOSE)
• 408 •
                SYSTEM-CONTROL = MP-CONTROL SYSTEM - AIR = MP - AIR
• 409 •
                SYSTEM-FANS-MP-FANS ...
. 410 .
• 411 •
. 412 . PA1+PLANT-ASSIGNMENT
            SYSTEM-NAMES+(BB-SYS,H-SYS,MP-SYS)
• 413 •
. 414 .
. 415 . SYSTEMS-REPORT
. 415 .
              SUMMARY + (SS-A)
. 417 .
• 418 • $ RSI=SCHEDULE THRU FEB ( 411) (1,24) (0)
· 419 ·
                      4 THRU MAR 15 (ALL) (1,24) (1)
• 420 •
                      $ THRU DEC 31 (ALL) (1.24) (01
. 421 -
. 422 . S RB1=REPORT-BIJCK
            & VARIABLE-TYPE-BASKETBALL
· 423 ·
             $ VARIABLE-LIST+(6,7,9,11,12,14,17,20)
• 424 •
· 425 ·
. 426 . $ RB2+REPORT BLOCK
            $ VARIABLE-TYPE-BB-515
• 427 •
             $ VARIABLE-LIST=(1,3,4.5,17,18,20,21,39) ...
· 428 ·
• 429 •
. 430 . S HRI=HOURLY-REPORT
            $ REPORT-SCHEDULE-RS1 REPORT-BLOCK-(RB1,RB2)
· 431 ·
• 432 •
• 435 • END
. 434 . COMPUTE SYSTEMS .
• 435 •
```

3

. 436 . IMPUT PLANT ...

PDL PROCESSOR INPUT DATA

82/09/29. 08:40:25. PDL PUN 1

```
• 437 •
 . 438 . . PARAMETER CAREA-3000 ...
 . 479 . S PARAMETER CFLOW-50
 . 440 . $ PARAMETER TVOL:5400 ...
 . 441 .
 . 447 .
 . 443 . CHILLERS . PLANT-EQUIPMENT
 . 444 .
                  TYPE OPEN-CENT-CHLR SIZE O. 600
 • 445 •
 . 446 . S HEAT-RECOVERY
 . 447 .
             S SUPPLY-1+(SCL-PROCESS-HEAT)
 . 448 .
              $ GEMAND-1=(PROCESS-HEAT) ...
 . 443 .
 • 450 •
 . 451 . LA1-LOAD-ASSIGNMENT
 • 452 •
            TYPETHEATING
 · 453 ·
            LOAD RANGE -999
 • 454 •
               PLANT-EQUIPMENT-UTILITY
 • 455 4
               NUMBER-999
 . 455 .
 * 457 * LOAD-MANAGEMENT
 • 459 •
             PRED-LOAD-RANGE=999
• 453 •
              LOAU-ASSIGNMENT=(LA1,DEFAULT,DEFAULT)
• 450 •
 . 451 . PLANT-PEPORT
             VERIFICATION-(PV-A)
 · 452 ·
 • 453 •
              SUMMARY (PS-A.PS-B.PS-D.BEPS) ...
 . 464 .
 · 465 ·
 . 466 - ENERGY-COST RESOURCE*STEAM UNIT+1000000 ...
 • 467 •
 . 469 . S SOLAR-EQUIPMENT .
 . 469 .
 . 470 . S SYSTEM TYPE=CLSH ...
 . 471 .
 • 472 •
 . 473 . $ INSOL .COMPONENT
             $ TILT=44 AZIMUTH=180.0 ..
 . 474 .
 · 415 ·
 . 476 . $ SUBSYS-COMPONENT
 • 477 •
              S COL-AREA-CAREA EFF-COEF+(.705. .. R87) ANGLE-COFF--0.1
              $ COL-FLOW-CFLOW PUMP-KW-15 TANK-VOL-TVOL LOAD FLOW-10.0.0)
 . 475 .
 · 479 ·
 • 450 •
 . 481 . END .
-CAUTION-------NO COOLING TOWER DEFINED, DEFAULT USED
 . 492 . COMPUTE PLANT
 . 483 . STOP
```

LDL PROCESSOR INPUT DATA 82/10/17, 15:32:31, LDL RUN I

١

```
3 •
       TITLE
                   LINE-1 -AIR FORCE ACADEMIA
                   LINE-2 *AEROMAUTICS LABORATOR++
                   LIME-3 -LOS ALAMOS MATTIMIAL LAB.
   4 .
   6 •
                   LINE-4 .ADJUSTED BASELINE. ..
   19084 • 9
                   ERPORS ..
   · •
   10 . DIAGNOSTIC ERRORS ...
  1; -
  12 . RUN-PERIOD JAN 1 1964 THRU DEC 31 1964 ...
  13 .
  14 -
                  SCHEDULES ....S
  15 •
   15 .
       PEOPLE-LIGHTS - SCHEDULE
                   THRU DEC 31 (ND) (1,7) (.1)
  17 -
  ...
                                    (9.17)(1)
  . .
                                    (18,24) (.1)
                               (WEH) (1,24) (.1) ..
  20 .
  21 .
  22 . INFILIRATION - SCHEDULE
                       THRU DEC 31 (NO) (1.7) (1)
. 27 .
  24 .
                                         (8,17)(.1)
                                         (19,24)(1)
  25 •
                                   (WEH)[1,24][1] ...
  25 .
. 27 .
. 28 . FIVE-HOURS-SCHEDULE
                    THRU DEC 31 (MS) (1.91 (0)
. 23 .
  70 .
                                     (10, 15) (1)
  71 .
                                     (16,24) (0)
. 32 .
                                (WEH)(1,24)(0) ...
. 37 . BUILDING-LOCATION
  34 .
                      LATITUCE - 39
  35 •
                      LONGITUDE . 105
                      ALTITUDE - 7100
  75 .
. 37 .
                      TIME-ZONE = 7 ...
  J. .
  33 •
                   S.... LAYERS
                                       ******
  49 .
 41 . EXT-WALL-1 . LAYERS
                      MATERIAL - (CC33,AL21,CB26,AL21,CB25,GFC3)
. 42 -
                      THICKNESS = (.1667..125..5..1667..5..0625) ...
. 47 .
  44 •
  45 .
        ROOF-LAYERS - LAYERS
                      MATERIAL - (BROY, INTA, CCCC, ACCC, ALCO, GEOG)
  45 .
                      THICKNESS . (.0313, 1667, 1667, 0625, 333, 0625) ...
- 47 -
  49 -
        CONCRETE . LAYERS
  13 •
                       WATERIAL = (CCOT)
  50 .
• 51 •
                       THICKNESS = (1,0) ...
. 52 .
  57 . UN-ROOF-LAYERS . LAIERS
  54 •
                       MATERIAL . (CC33,BF07,CC07)
• 55 •
                       THICKNESS - (.25.,0025,1.0)
• 56 •
. 57 . BLOCK-LAYERS - LAYERS
```

```
5A .
                        MATERIAL - (CB26,GP03)
  53 .
                        THICKNESS # (.5..0625) ...
  50 . TCCR-LAYERS . LAYERS
  51 .
                         MATERIAL # (CCOT.AL21.5003.IN23)
  52 .
                         THICKNESS = (1.0,.25,.3333,.1667) ...
  67 .
  54 . STEEL-DOOR . LAYEDS
  c5 •
                         MATERIAL - (IND1)
  55 .
                         THICKNESS . (.09) ...
  57 .
  59 .
        STEEL-COORS . LAVERS
  69 •
                         MATERIAL - (AL21)
  77 .
                         THICKNESS . (.0833) ...
          WALL HAS NO HEAT CAPACITY. U-VALUE WILL BE CALCULATED AND USED.
  71 -
  72 .
                      ......
                                   CONSTRUCTIONS .....
  77 •
  74 . PRE-CAST-CONCRETE . CONSTRUCTION
  75 •
                         LATERS - EXT-WALL-1
  76 .
                         ABSCRPTANCE . .55
  71 -
                         ROUGHNESS . 1 ...
  78 .
   73 .
        ROOF-COMS . CONSTRUCTION
  ₽7 •
                         LAIERS - ROOF-LAIERS
  . .
                         ABSOMPTANCE - 5
   ., .
                         ROUGHNESS = 1 ...
 P7 .
         UNDERGROUND ROOF - CONSTRUCTION
  24 .
  85 .
                         LAYERS - UN-ROOF-LAYERS ...
  P (, .
  P7 -
         CONCRETE-FLOOR . CONSTRUCTION
. FQ .
                         LAYERS . CONCRETE ...
  P7 .
  37 .
        POURED-CONCRETE - CONSTRUCTION
   3. .
                         LAYERS . ASIM-40 ...
  92 .
  23 * CONCRETE-BLOCK * CONSTRUCTION
  34 .
                         LAYERS . BLOCK-LAYERS ..
  75 .
  26 .
        MO-WALL . CONSTRUCTION
  37 .
                         U-VALUE - 10 ...
  2 A .
. 33 . TCCR-WALL . CONSTRUCTION
                         LAVERS . TCCR-LAYERS ..
. 15,57 .
. 121 .
. 1/17 . STEEL-PANEL-DOOR - CONSTRUCTION
. 1/;7 .
                         TAVERS . STEEL-COOR
· 1/14 ·
                          ARSORPYANCE - .B
• 175 •
                         POUGHNESS = 5 ...
. 175 .
. 107 . ROLL-UP-DOOR - CONSTRUCTION
. 1/-9 .
                         LAVERS . STEEL-DOORS
. 143 -
                         ABSORPTANCE = .8
. 119 .
                          ROUGHNESS . 5 ...
. . . .
. 112 . GLASS-DOOR . GLASS-TYPE
. 117 .
                         PANES - 1
. 114 -
                         GLASS-TYPE-CODE . 10 ...
. 115 .
                    $ . . . . . . . .
                                 SPACES - FIRST FLOOR
. 115 -
. 117 .
. 118 . COMDITIONS . SPACE-COMMITTIONS
                           REORLE-SCHEMILE - REORLE-LIGHTS
. 117 .
• 129 •
                           PEOPLE-HG-LAT + 279
```

```
• 171 •
                            PEOPLE-11G-SEHS = 250
 • 122 •
                            LIGHTING-SCHEDULE - PEOPLE-LIGHTS
                            FLUOR-WEIGHT = 0
 • 123 •
 • 124 •
                            INF-METHOD - AIR-CHANGE
 · 125 ·
                            AIR-CHANGES/HR = 5
• 176 •
                            INF-SCHEDULE = INFILTRATION ...
. 127 -
. 179 . TRISONIC - SPACE
• 123 •
                           X=150.78
                                        Y = 0
                                                 2 - 15
• 130 •
                           SHAPE . BUC
• 131 •
                           REIGHT = 19.5 | WIDTH = 63.9 | DEPTH = 41.88
• 132 •
                           SPACE-COMMITTIONS = COMMITTIONS
. 133 .
                           PUMPER OF PEOPLE = 6
. 174 .
                           LIGHTING-KW # 7.2 ..
. 175 .
. 175 .
                           TRISONIC - LOOR - INTERIOR-WALL
. 137 .
                                 HEIGHT = 41,88
. . . .
                                 WIDIH = 69.9
. 173 .
                                 LOCATION - POTTOM
• 140 •
                                 CONSTRUCTION - CONCRETE-FLOOR
- 141 -
                                 NEXT-TO . MECHANICAL ..
• 147 •
. 143 -
                            TRISONIC-NORTH = EXTERIOR WALL
- 144 -
                                  CONSTRUCTION = PRE-CAST-CONCRETE
. 145 .
                                  HEIGHT # 19 5
• 145 •
                                  WIDTH = 63.9
• 147 •
                                  LOCATION . BACK
- 149 -
- 143 -
                            TRISONIC SOUTH - EXTERIOR WALL
. 150 .
                                  LIKE # TRISONIO-NORTH
. 151 .
                                  LCCATION - FRONT ...
• 152 •
• 157 •
                            TRISONIC-EAST = EXTERIOR-WALL
· 154 ·
                                  CONSTRUCTION + PRESCAST COMMRETE
• 155 •
                                  HEIDHT - 19 5 WIDTH = 41 89
. 156 .
                                  LOCATION . PIGHT ...
• 157 •
• 159 •
                            TRISONIC-ROOF = ROOF
. 153 .
                                  CONSTRUCTION - ROOF-CONS
• 150 •
                                  HEIGHT = 41.89 WIDTH = 69.9
. 161 .
                                  LOCATION - TOP . .
. 152 .
. 163 .
. 164 . COMBUSTION . SPACE
. 155 .
                            7 - 111,P0 Y=0
                                                2 * 15
. 155 .
                            SHAPE - BOY
. 157 .
                            PEIGHT # 19 5
• 108 ·
                            WIDTH = 41,94
                            DEPTH = 75.0
• 169 •
- 179 -
                            SPACE - CONDITIONS = CONDITIONS
. 171 .
                            MANABER-OF PEOPLE = 10
· 172 ·
                            LIGHTING-KW = 2.0 .
. 177 .
· 174 ·
                            COMBUSTION-EAST - INTERIOR-WALL
                                  HEIGHT = 19.5 - WIDTH = 36
• 175 •
                                  LOCATION - PIGHT
. 176 .
• • 17 •
                                  CONSTRUCTION - CONCRETE-BLOCK
- 178 -
                                  NEXT-TO # TRISONIC ...
. 179 .
· 180 -
                            COMBUSTICH-WEST - INTERIOR-WALL
. 191 .
                                  HEIGHT * 19.5
                                  MIDIH - 36 0
· 192 •
· 193 ·
                                  LOCATION - LEFT
. 194 .
                                  CONSTRUCTION * CONCRETE BLOCK
```

```
. 195 -
                                     NEXT-TO . LOSBY-1 ...
   • 185 •
   . 197 .
                                COMBUSTION-SOUTH . ETTERICE-WALL
   . 189 .
                                     CONSTRUCTION . PRE-CAST-CONCRETE
   . 163 .
                                     HEIGHT + 19.5 WIDTH + 41.94
   • 130 •
                                     LOCATION - TRONT
   . 17! .
   . 132 .
                               COMBUSTION WORTH - INTERIOR-WALL
   • 133 •
                                     HEIGHT = 19.5 WIDTH = 41.94
   . 174 .
                                     LOCATION - BACK
   . 175 .
                                     CONSTRUCTION . COMPRETE BLOCK
   . 135 .
                                     NEXT-TO . NORTH-LOSSY ...
   • 197 •
   · 138 ·
                               COMBUSTION-FLOOR - INTERIOR-WALL
   . 133 .
                                     HE19HT = 35 WIDTH + 41.94
   • 250 •
                                     LOCATION . POTTOM
   • 201 •
                                     CONSTRUCTION = CONCRETE-FLOOR
   • 202 •
                                     NEXT-10 * SHOP ...
   • 273 •
   . 201 .
                               COMBUSTION-ROOF = ROOF
   . 705 .
                                     CONSTRUCTION = ROOF-CONS
   • 255 •
                                     HEIGHT = 36 WIDTH = 41.94
   . 201 .
                                     LOCATION = 10P ...
   - 219 -
   · 2013 ·
   . 210 . NORTH-LOSSY . SPACE
   . 211 .
                                **#3.88 Y=36 Z=15
   . 212 .
                                SHAFE - BOT
   . 217 .
                                HEIGHT = 19.5 WIDTH = 69.9 DEPTH = 5.88
   . 7.4 .
                                SPACE-CONDITIONS = CONDITIONS
   . 2.5 .
                                LIGHTING-TIPE . THEAND
70 - 215 -
                                LIGHTING-KW = .24
  . 217 .
                                AIR-CHANGES/HR # 1.0 ..
   . 219 -
   . 217 .
                               NORTH-LOBBY-NORTH - EXTERIOR-VALL
   . 729 .
                                     HEIGHT = 19.5 | VIDTH = 69.9
   • 221 •
                                     COMSTRUCTION - PPE-CAST-CONCRETE
   • 222 •
                                     LOCATION = BACK ...
   . 223 .
   · 224 ·
                                     NORTH-COOR = WILLOOW
   • 225 •
                                           GLASS-TIPE = GLASS-DOOR
   • 725 •
                                           X = 43.9 Y=0
   • 227 •
                                           HEIGHT . 17.6 210TH . 26 0 ...
   • 72B •
   • 223 •
                               NORTH-LOSSY-FLOOR - INTERIOR-WALL
   · 230 ·
                                     HEIGHT . S. PA
   . 231 .
                                     ¥107H = 53.9
   • 232 •
                                     LOCATION = POITON
   • 231 •
                                     CONSTRUCTION = CONCRETE-FLOOR
   • 234 •
                                     NEXT-TO = LOSGY-A ...
   • 235 •
   • 235 •
                               NORTH-LOBBY-ROOF * ROOF
   • 777
                                     CONSTRUCTION + ROOF - CONS
   . 218 .
                                     HELCHT - 5.89 WIDTH + 69 9
   . 233 -
                                     LOCATION - TOP ...
   . 210 .
   . 211 . LOBB1-1 . SPACE
                               * - 83.88 Y-0 Z+15
   . :17 .
   . 247 .
                               SHAPE . BOT
   - 244 -
                               HEIGHT + 19.5 WINTO - 78 DEPTH - 36
                               SPACE-CONDITIONS + CONDITIONS
   • . 17, •
   • 245 •
                               INJMHER-OF-PEOPLE - 2
   . 247 .
                               LIGHTING TYPE + INCAM)
   . 729 .
                               LIGHTING-KW + 2 4
```

```
- 251 -
                               LOSBY-1-MORTH = INTERIOR-WALL
    • 252 •
                                     HEIGHT = 19 5 WIDTH = 28
    • 253 •
                                     LOCATION = FACK
   • 254 •
                                     CONSTRUCTION = NO-WALL
   • 255 •
                                     NEXT-TO = NORTH-LOBBY ...
   • 255 •
   • 257 •
                               LOBBY-1-SOUTH - EXTERIOR-WALL
   • 759 •
                                     CONSTRUCTION * PRE-CAST-CONCRETE
   • 259 •
                                     HEIGHT = 19.5
   • 250 •
                                     MICTH = 28
   • 251 •
                                     LCCATION = FFONT ...
   • 252 •
   · 257 ·
                               LOBBY- 1 FLOOR - INTERIOR-WALL
   • 254 •
                                     HEIGHT - 36 WILLIAM - 28
   • 255 •
                                     LOCATION - POTTON
   • 265 •
                                     CONSTRUCTION - CONCRETE-FLOOR
   · 257 ·
                                     NEXT-TO = LOBBY-A ...
   • 278 •
   • 253 •
                               LC88Y-1-ROOF = ROOF
   • 270 •
                                     CONSTRUCTION = PONF-CONS
   . 271 -
                                     HEIGHT = 35 WIDTH = 28
   • 272 •
                                     LOCATION - TOP ...
   . 273 .
   . 274 . SUBSONIC - SPACE
   • 275 •
                               LIKE TRISCHIC
   • 275 •
                                   X=0 WIDTH = 83.88
   • 277 •
                                   NUMBER-OF-PEOPLE = 6
   • 278 •
                                   LIGHTING-KE = 7.1
   . 273 .
                                   EQUIP-SCHEDULE = FIVE-HOURS
   · 2P9 ·
                                   EQUIPMENT-KW = 150 ...
   • 291 •
   - 222 -
                                   SUBSONIC-FLOOP = IMTERIOR WALL
HEICHT = 41 88 WIDTH = 69.9
   · 284 ·
                                         FOCATION - BOLLOW
   · 295 ·
                                         CONSTRUCTION + CONCRETE FLOOR
   · 285 ·
                                         NEXT-TO = SHOP ...
   - 297 -
   . 200 .
                                   SUBSONIC-MORTH . EXTERIOR-WALL
   • 793 •
                                         CONSTRUCTION = PRE-CAST-CONCRETE
   • 200
                                         HEIGHT - 19.5
   • 231 •
                                         LOCATION - BACK
   • 232 •
                                         ₩IDTH = 83.98
   • 237 •
   . 234 .
                                   SUBSONIC-SOUTH = FITERIOR-WALL
   . 775 .
                                         TIME TRISONIC-SOUTH
   • 225 •
                                         WIDTH = 83.88 ...
   . 237 .
   . 77.0 .
                                  SUBSCRIC-RODE - PODE
   . 273 .
                                        LIKE TRISONIC-POOF
   . 3.0 .
                                         WIDTH = 83 88 ...
   • 301 •
   . 302 -
                                  SUBSONIC-WEST - EXTERIOR-WALL
   • 503 •
                                        LIKE TRISONIC-EAST
   • 304 •
                                         LOCATION . LEFT ...
   • 305 •
   • 355 •
                                  SUBSONIC-EAST + INTEDIOR-WALL
   · 307 ·
                                        HEIGHT - 19 5 WIDTH # 41,88
   • 308 •
                                        LOCATION = PIGHT
   • 303 •
                                        CONSTRUCTION - CONCRETE-BLOCK
   • 310 •
                                        NEXT-70 - LORBY-1 ...
  • 311 •
  • 312 •
                         SPACES - LOWER LEVEL A
```

AIR-CHANGES/HR = 1 0 .

• 743 •

· 250 ·

```
. 3.6 ·
                               SPACE-CONDITIONS = CONDITIONS
   . 317 .
                               NUMBER-OF-PEOPLE - 4
   • 320 •
                               LIGHTING-KW # 10,4
   • 321 •
                               EQUIP-SCHEDULE = FIVE-HOURS
   • 377 •
                               EQUIPMENT-KW = 50 ...
   • 323 •
   · 324 ·
                               SHOP-MORTH = UNDERGROUND-WALL
   • 325 •
                                     HEIGHT + 15 WIDTH + 111.8
   . 725 .
                                     LOCATION - BACK
   • 327 •
                                     CONSTRUCTION = POURED CONCRETE ...
   • 329 •
   • 323 •
                               SHOP-SOUTH = EXTERIOR WALL
   • 330 •
                                     CONSTRUCTION . POURED-CONCRETE
   • 331 •
                                     HEIGHT = 15 WIDTH = 111.8
   • 332 •
                                     LOCATION - FRONT ...
   • 717 •
   • 334 •
                                     SHOP-1 = DOOR
                                           HEIGHT = 11 25 WIDTH = 14 0
   • 775 •
                                           CONSTRUCTION . ROLL-UP-DOOR
   . 275 .
   • 317 •
                                           X = 35
   • 335 •
                                            Y . O . .
   • 313 •
   . 317 .
                                     SHOP-2 * 0002
                                           HEIGHT = 11.33 RIDTH - 13.5
   . 741 .
                                            CONSTRUCTION * STEEL-PANEL-DOOR
   • 342 •
72 : 217 :
                                            X * 88.3 Y * O ...
  • 344 •
                                SHOP-FLOOR = UNDERGROUND-FLOOR
   • 345 •
                                     HEIGHT = 41.88 VIDIH = 111.8
    . 345 .
    • 347 •
                                      MOTTON = BOTTOM
    . 349 .
                                      CONSTRUCTION . CONCRETE-FLOOR ...
    . 349 -
                                 SHOP-EAST . INTERIOR WALL
    • 750 •
    . 351 .
                                     HEIGHT = 15 WIDTH = 41.88
                                     LOCATION = PIGHT
    • 352 •
    . 253 .
                                     CONSTRUCTION - CONCRETE-BLOCK
    • 354 •
                                     NEXT-TO . LOBBY-A ...
    . 355 .
    • 355 •
            LOBBY-A - SPACE
                               X = 111.8 Y = 5.88 Z = 0
    • 357 •
    • 359 •
                               SHAPE - BOX
    • 353 •
                               HEIGHT = 15 WIDTH = 28 DEPTH = 36
    • 300 •
                               SPACE-CONDITIONS - CONDITIONS
    . 251 .
                               LIGHTING-TYPE . INCAND
    • 352 •
                               LIGHTING-KW = 1.96 ...
    • 353 •
    . 754 .
                               LCBBY-A-SOUTH - [NTER[OR-WALL
    • 355 •
                                      HEIGHT = 15 WIDTH = 28
    . 3CE .
                                      LOCATION = FRONT
    • 357 •
                                      CONSTRUCTION - NO WALL
    • 358 •
                                      NEXT-TO . SOUTH-LORRY ...
    • 363 •
                               LOSSY-A-NORTH - UNDERGROUND WALL
    · 3;/) ·
                                     HEIGHT = 15 WIDTH = 28
    . 371 .
    • 312 •
                                      LOCATION - FACK
```

CONSTRUCTION + FOURED-CONCRETE ...

LOBBA-W-LEGGE . CAMERCEGAMAN-EFGGE

*** 36**

SHAFE - BOX

DEPTH # 41.88

HEIGHT = 15 WIDTH = 111.8

• 372 •

. 374 .

• 275 • · 376 ·

• 313 •

. 315 .

• 316 •

. 317 .

. 314 . SHOP . SPACE

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73
```

```
• 377 •
                                  WIDTH = 29
• 378 •
                                  LOCATION - BOITOM
• 379 •
                                  CONSTRUCTION . CONCRETE-FLOOR ...
• 380 •
• 791 •
         SCUTH-LCBBY - SPACE
• 365 •
                            X = 111.8
• 383 •
                            7 = 0 Z = 0
· 394 ·
                            SHAPE = 80%
• 395 •
                            HEIGHT = 15 WIDTH = 29 DEPTH = 5 88
• 355 •
                            SPACE-COMMITIONS - COMMITIONS
. 707 .
                            LIGHTING-TIPE = INCAND
· Jeg ·
                            LIGHTING-KW = .4 ...
• 383 •
• 130 •
                            SOUTH-LOSSY-SOUTH # ETTERTOR WALL
. 771 .
                                  CONSTRUCTION - FOURED-CONCRETE
• 332 •
                                  HEIGHT = 15 WIDTH = 28
• 333 •
                                  LOCATION = FRONT ...
• 334 •
• 335 •
                                  LOBBA-Y-DCGG - MINDOM
. 326 .
                                        GLASS-TYPE - GLASS-DOOR
• 337 •
                                        X-7 Y=0
- 378 -
                                        HEIGHT = 11.25 WIDTH = 13.5 ...
• 333 •
. 150 .
                            SOUTH-LORGY-FLOOR - INCEPTROMAD-FLOOR
. 491 .
                                  HEIGHT = 5,89 WINTH = 28
. 4-2 .
                                  LOCATION = POTTON
• 103 •
                                  CONSTRUCTION = CONCRETE-FLOOR ...
. 404 .
• 405 •
         MECHANICAL - SPACE
. 415 .
                            7 - 139 8 Y = 0 Z = 0
. ASI .
                            SHAPE . BOY
• 409 •
                            HEIGHT = 15 WIDTH = P4 DEPTH = 41 PR
. 47.3 .
                            SPACE-COMMITTONS - CONDITIONS
. 419 .
                            NUMBER-DE-PEOPLE = 2
. 411 .
                            LIGHTIN TYPE = INCAND
. 117 .
                            LIGHTING KW = 4.4
. .17 .
                            ECUIP-SCHEDULE - PEOPLE-LIGHTS
. 4:: -
                            EQUIPMENT-KW = 50 ...
. 415 .
- 415 -
                            MECHANICAL-EAST - INTERIOR-WALL
. 417 .
                                  HE!GHT = 15
. 410 -
                                  WIDTH = 41,89
. 4:3 -
                                  LOCATION = PIGHT
• 429 •
                                  CONSTRUCTION - CONCRETE-FLOOR
. 471 .
                                  NEXT-TO = TEST-CELL .
• 472 •
                            MECHANICAL-WEST - INTERIOR-WALL
. 423 .
• 424 ·
                                  HELPHY = 15 WIDTH + 41.88
· 425 ·
                                  LOCATION - LEFT
475 .
                                  CONSTRUCTION - CONCRETE-BLOCK
. 471 .
                                  NEXT-TO = LOBSY-A ...
. 479 .
. 423 .
                            MECHANICAL-SOUTH - EXTERIOR-WALL
. 439 .
                                  CONSTRUCTION - FOURED-CONCRETE
. 431 -
                                  HEIGHT = 15 WIDTH * 84
. 432 .
                                  LOCATION * FRONT ...
. 437 .
. 474 .
                                  MECH-DOORS - DOOR
. 475 .
                                        HEIGHT = 11 25
. 475 .
                                        6101H - 13 5
. 437 -
                                        CONSTRUCTION . STEEL-PANEL DOOR
. 439 .
                                        7 - 7 25 ( - 0 MULTIPLIER + 3 ).
. 433 .
                           MECHANICAL -FLOOR = UNDEPGROUND - FLOOR
                                  HEIGHT . 41.88 WIDTH . 84
· 440 ·
```

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74
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• 504 •

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. 441 -
                                  LOCATION = POITON
. 412 -
                                  CONSTRUCTION . CONCRETE-FLOOR ...
 . 443 .
 . 444 -
                            MECHANICAL-NORTH = UNDEPGROUND-WALL
. 445 .
                                  HEIGHT = 15 WIDTH = 84
. 415 .
                                  LOCATION - RACK
· 447 ·
                                  CONSTRUCTION * POURED-CONCRETE ...
• 449 •
• 143 •
         TEST-CELL = SPACE
• 459 •
                            X = 223 8 Y = 0 Z = 0
. 451 .
                            SHAPE . BOX
• 452 •
                            HEIGHT * 15 WIDTH = 56 DEPTH = 58
• 453 •
                            SPACE-CONDITIONS * COMOLITIONS
. 451 .
                            LIGHTING-TYPE = INCAND
• 455 •
                            LIGHTING-KW = 8.4 ...
. 455 .
• 457 •
                            TEST-CELL-SOUTH = EXTERIOR WALL
• 458 •
                                  CONSTRUCTION - FOURED CONCRETE
. 453 .
                                  HEIGHT = 15 WIDTH = 56
• 150 •
                                  LOCATION = FRONT ...
. 401 -
• 452 •
                                  TEST-CELL-POORS = DOOR
· 457 •
                                        HETCHI = 11 0 MIDIH - 14
* 454 *
                                        CONSTRUCTION . POLL-UP DOOR
. AF5 .
                                        * * O F = O MULTIPLIER * 4 ...
• 455 •
                            TEST-CELL-WALL = UNDERGROUND-WALL
· 457 ·
                                  HEIGHT = 15 WIDTH = 114
· 469 ·
                                  LOCATION - PACK
• 453 •
                                  CONSTRUCTION * POURED-CONCRETE ...
. 419 .
• 471 •
                            TEST-CELL-ROOF - UNDERGROUND-WALL
. 472 -
                                  HEIGH) = 58 WIDTH = 56
. 473 .
                                  LOCATION = TOP
                                  CONSTRUCTION = UNDERGROUND ROOF
• 474 •
· 475 ·
. 4:5 .
                            TEST-CELL-FLOOR = UNDERGROUND-FLOOR
. 477 .
                                  HEIGHT * 58
• 478 ·
                                  WIDTH = 56
. 473 .
                                  LOCATION - BOTTOM
• 499 •
                                  CONSTRUCTION = CONCRETE-FLOOR ...
· 481 •
• 4<u>82</u> •
         TEST-CELL-CR . SPACE
· 423 ·
                            X = 273.9 Y = 0 Z = 0
· 404 ·
                            SHAPE - BOX
. 425 .
                            HEIGHT = 15 WIDTH = 54 DEPTH = 58
· 405 ·
                            SPACE-CONDITIONS = CONDITIONS
· 497 ·
                            MUMBER-OF-PEOPLE - 13
• 488 •
                            LIGHTING-KW = 5.2 ..
· 4P3 ·
· 474) ·
                            TEST-CELL-CR-SOUTH = EXTERIOR-WALL
• 471 •
                                  CONSTRUCTION - FOURED CONCRETE
. 477 .
                                  HEIGHT = 15 WIDTH = 54
• 473 •
                                  LOCATION = FRONT ..
. 444 .
. 475 .
                                  TEST-CELL CR-DOOR - COMR
• 475 •
                                        HEIGHT = 11 MICH = 6
• 497 •
                                        CONSTRUCTION - STEEL-PANEL-DOOR
. 470 .
                                        X = 10.6 Y = 0 MULTIPLIER = 2
433 4
+ 500 ×
                            TEST-CELL-CR-POOF = UNDERGROUND WALL
• 501 •
                                  HEIGHT = 58 WIDTH = 54
• 5/12 •
                                  LOCATION - TOP
. . .
                                  CONSTRUCTION - UNDERGROUND-RODE ...
```

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TEST-CELL-CR-FLOOR = UNDERGROUND-FLOOR
HEIGHT = 58 WIDTH = 54
• 505 •
• 500 •
                                    CONSTRUCTION . CONCRETE-FLOOR ...
• 507 •
• 508 •
• 509 •
                             TEST-CELL CR-INT = INTERIOR-WALL
· 510 ·
                                    H[[GHT = 15
• 511 •
                                    WIDTH = 170
                                    LOCATION - PACK
CONSTRUCTION = TOCE-WALL
· 512 ·
• 513 •
                                    NEXT-TO - TEST-CELL ...
• 514 ·
. 515 . BUILDING-RESOURCE
                             HW-SCHEDULE = PEOPLE-LIGHTS
• 516 •
• 517 •
                             HOT-WATER = 4700 ...
. 518 .
. 512 .
. 520 . LOADS-REPORT
• 521 •
                         SUMMARY = (ALL-SUMMARY) ...
• 522 •
• 523 • END ...
• 524 •
. 525 . COMPUTE LOADS ...
. 526 . INPUT SYSTEMS ...
```

75

SDL PROCESSOR INPUT DATA

82/10/17. 15:32:31, SDL RUN 1

```
• 527 •
  . 528 . HEAT-SCHEDULE
  • 523 •
                               THRU MAY 15 (ALL)
  • 530 •
                               (1,7)(62.5)(8,17)(70.5)(18,24)(62.5)
  • 531 •
                               THRU SEP 30 (ALL)
  • 572 •
                                (1,7)(62,5)(8,17)(70,5)(18,24)(62.5)
  • 533 •
                               THRU DEC 31 (ALL)
  • 574 •
                               (1,7)(62.5)(8,17)(70.5)(18,24)(62.5) ...
  • 535 •
           COOL - SCHEDULE
  + 535 +
                               THRU MAY 15 (ALL)
  . 537 .
                               (1,7)(67.5)(8,17)(75.5)(18,241(67.5)
  • 538 •
                               THRU SEP 30 (ALL)
  • 533 ·
                                (1,7)(57.5)(8,17)(75.5)(18,24)(67.5)
  . 5 17) .
                               THRU DEC 31 (ALL)
  · 541 ·
                               (1,7)(67.5)(8,17)(75.5)(18,24)(67.5) ...
   • 512 •
  . 543 . HEATZ=SCHEDULE
  • 544 •
                               THRU MAY 15 (ALL)
   . 515 .
                               (1,7)(60.0)(8,17)(68.0)(18,24)(50.0)
  • 515 •
                                THRU SEP 30 (ALL)
  • 541 •
                                (1,7)(60.0)(8,17)(58.0**18,241(60.0)
  • 518 •
                               THRU DEC 31 (ALL)
0 . 243 .
                               (1.7)(60.0)(8.17)(68.0)(18.24)(60.0) ...
  • 550 •
           COOL2*SCHEDULE
  • 551 •
                               THRU MAY 15 (ALL)
  • 552 ·
                               (1,7)(90.0)(2,17)(78.0)(18,24)(90.0)
  553 •
                               THRU SEP 30 (ALL)
  . 554 .
                                (1,7)(90.0)(8,17)(78.0)(18,24)(90.0)
  • 555 •
                               THRU DEC 31 (ALL)
  • 556 ·
                               (1,7)(90.0)(8,17)(78.0)(18,24)(90.0) ...
   . 557 .
  • 55B •
  • 559 •
           HEAT1 - SCHEDULF THRU DEC 31 (ALL)
  • 550 •
                          (1,7)(62.5)(8,17)(70.5)(18.24)(62.5) ...
  • 551 •
  • = 5,7 •
           COOL 1 - SCHEDULE THRU DEC 31 (ALL)
  • 553 •
                          (1,7)(67.5)(8,17)(75.5)(18,24)167.5) ...
  . 564 .
  • 565 •
            MIN-AIR - SCHEDULE
  . 555 .
                           THRU DEC 31(ALL)(1,7)(0)
  . 557 .
                                      (8, 17)(.041)
  • 508 •
                                      (18,24)(0) ...
  · 509 ·
           MIN-AIR1 . SCHEDULE
  • 5:9 •
                           THRU DEC 31(ALL)(1,7)(0)
  . 571 .
                                      (8, 17)(.12)
   . 572 -
                                      (18,24)(0) ...
  . . . . .
           MECH-HTG+SCHEDULE
  . 5.14 .
  . 575 .
                                THRU MAY 15 (ALL)(1,24)(1)
  · 5/6 ·
                               THPU SEP 30 (ALL)(1,24)(1)
  • 577 •
                               THRU DEC 31 (ALL)(1,24)(1) ...
  • 578 ·
            MECH-CLG=SCHEDULE
                                THPU DEC 31 (ALL)[1,7](0)[8,17](1)[18,24][0] ...
  • 573 •
  • 520 •
  . 591 .
           MECH-COOL . SCHEDULE TURBLE DEC 31 (ALL)
  • 1,07 •
                           (1,214,51)
```

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SI-FANS . SCHEDULE
 . 505 .
                        THRU DEC 31 (90)(1,7110)
 . 506 .
                                          (0.17)(1)
• 587 •
                                          (18,241(0)
 · 588 ·
                                        (WEE)(1,24)(0) ...
• 583 •
 . 590 . TEST-CELL-HEAT = SCHEDULE
 • 591 •
                        THRU DEC 31 (ALL)(1,24)(60) ...
 • 532 •
 . 593 . LGEBY . SCHEDULE
 • 534 •
                              THRU DEC 31 (ALL)[1,7)[68][8:17](68)[18.24][68] ...
 • 595 •
 . 576 . REPORT . SCHEDULE
 . 577 .
                         THRU JAN 13 (ALL)(1 24)(1)
 • 538 •
                         THPU JUN 17 (ALL)(1,24)(0)
 • 599 •
                         THRU JUN 27 (ALL)(1,24)(1)
 • 600 •
                         THRU DEC 31 (ALL)(1,24)(0) ...
 • 501 •
 . 502 . Z-CONTROL = ZONE-CONTROL
 • 693 •
                        DESIGN-HEAT-T = 70
 · 504 ·
                        HEAT-TEMP-SCH = HEAT
 • 655 •
                        DESIGN-COOL-T = 71
                        COOL-TEMP-SCH - COOL
 • 696 •
. 677 .
                        THROTTLING-RANGE = 5.0 ...
 . 559 .
 + 569 + Z-CTPL * ZONE-CONTPOL
 · 510 ·
                        DESIGN-HEAT-T - 70
 . 511 .
                        HEAT-TEMP-SCH = HEATT
 . 512 .
                        DESIGN-COOL-1 = 75
 · 613 ·
                        COOL-TEMP-SCH - COOL 1
 • 514 •
                        THROTTLING-RANGE = 5.0 ...
. 515 . SUBSONIC . ZONE
. 515 .
                      $ ASSIGNED-CFM = 5677
+ 617 +
                        DESIGN-HEAT-T=70
+ 618 ·
                        HEAT-TEMP-SCH-HEAT2
 . 513 .
                        DESIGN-COOL-1=71
 . 525 .
                        COOL - TEMP - SCH = COOL 2
 • 6,21 •
                        THERMOSTAT-TYPE=TWO-POSITION ...
• 522 •
 • 523 • LOBBY-1 = ZONE
. 624 .
                      $ ASSIGNED-CFM = 385
 • 525 •
                        ZONE-CONTROL = Z-CONTROL ...
 · 525 •
 . 621 . SHOP = ZCHE
. 578 .
                      $ ASSIGNED-CEM = 1285
 • 623 •
                        ZONE - CONTROL * Z-CONTROL ...
. 539 .
. 631 . COMPUSTION - ZONE
. 532 .
                      $ ASSIGNED-CEM + 2154
• 677 •
                        ZONE-CONTROL * Z-CONTROL ...
• 534 •
. 635 . TRISONIC . ZONE
. 676 .
                      $ ASSIGNED-CFM = 4231
                        ZOME-CONTROL - Z-COMTROL ...
• 537 •
. FOR . MECHANICAL - ZONE
. 633 .
                        DESIGN-HEAT - T = 60
• 540 •
                        HEAT-TEMP-SCH = TEST-CFIL-HEAT
. 541 .
                        DESIGN-COOL - 1 = 75
· 5/12 ·
                        COOL - TEMP - SCH = MECH-COOL
                        ASSIGNED-CFM = 4385 ...
· 643 ·
• F44 •
. 515 . TEST-CELL - ZUNE
• 546 •
                        DESIGN-HEAT-T = GO
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• 547 •
                           HEAT-TEMP-SCH . TEST-CELI-HUAT
   • 649 •
                           ASSIGNED-CFH = 2277
   • 549 •
                           DEGIGN-COOL-T = 90
   · 550 ·
                           HEATING-CAPACITY . - 136000
   . 554 .
   . ftp . TEST-CELL-CR . ZONE
   • 557 •
                           ZONE - CONTROL + Z CTHL
   . 554 .
                           ASSIGNED-CFM = 2569
   1 155 .
                           HEATING-CAPAC TY - 154000
   · 656 ·
                           COULING-CAPACITY = 92400 ...
   . 657 .
   . F. . LOBBY-A . ZONE
   • 553 •
                           DESIGN-HEAT-T = 72
   . ....
                           HEAT-TEMP-SCH = LOBRY
   . ...
                           DESIGN COO1 - * 80
   . ....
                           BASEBOARD-C-RL = THERMOSTATIC
   . 563 .
                           BASEBOARD-RATING - - 8000
   . . . .
                           ASSIGNED-CFM = 400 ...
   • 555 •
   . SES . SOUTH-LORBY . ZONE
   • 657 •
                           DESIGN-HEAT - T = 72
   · eca ·
                           HEAT-TEMP-SCH . LOBBY
   • FC3 •
                           DESIGN-COOL-F # 80
   • 579 •
                           ASSIGNED-CFM . 446 ...
   . 571 . NORTH-LOSSY . ZONE
   • 6:7 •
                           DESIGNATION TO THE TO
   . 6.7 .
                           HEAT-TEMP-SCH = LOBBY
   • 574 •
                           DESIGN-COCK-T * FO
   • 675 •
                           ASSIGNED-CFM . 669 ...
   + 515 +
   + CTF + SISUB+SYSTEM
S . 5 . 9 .
                           ZONE - NAMES = (SUBSONIC)
   • F79 -
                           SISTEM-TYPE=SZEH
   . ...
                           "44 - SUPPLY - T = 120
   . 691 .
                           MIN-SUPPLY-T=54
   . 692 .
                           ECONO-LIMIT-T+78
   • 663 ·
                           HEATING - SCHEDULE - MECHINICA
   • CB: •
                         $ COOLING SCHEDULE = MECH-CLG
   · FPS ·
                           SUPPLY-CFM-26973
   . . .
                           COOL-CTRL-PANGE=2.0
   . . . .
                           MIN-AIR-SCH-MIN AIR
   . . .
                           MIGHT - CYCLE - GIRL + C+5LE - ON-AN+
   . . . .
                           FAN-SCHEDULE*SI-FANS ...
   • 570
   · FOI · SI = SYSTEM
   . . . . .
                           SYSTEM-TYPE - M75
   • 643 •
                           ZONE-MAMES = (LOPHY-1, SHOO, COMP - STIDM, TRISOMIC)
   . 5.4 .
                           MAI-SUPPLY-T = 100
   . . . .
                           MIPH-SUPPLY-T = 51
   . ....
                           HEAT-UPWIEDL - CONSTANT
   . 6.4
                           COOL-CONTROL = CONSTANT
   . 652 .
                           5001-SET-T # 64
   . 1:3 .
                           BC - T-TIMIJ-CMD03
   . .
                           SUPPLIFORM # 13831
   . - . .
                           COOL-CIRL-RANGE - 2 0
   . . . . . .
                           MIN-AIR-SCH # MIN-AIR
   . 70 1 .
                           ZUPPLEA - KM = 10003€
   · *4.4 ·
                           BELLIGHTAR # 100053
   - 715 -
                           PETURN-DELTA-T + 70
   • 76,6; •
                           SUPPLY DELTART + 1 95
   . . . .
                           HEATING-SCHEDULE-HOCH HIS
   . ~ .
                         $ COCCING-SCHEDULE +MECH 1.5
   • 7r % •
                           CONLING-CAPACITY + 50% 100
   · 710 ·
                           HEATING-CAPACITY . - TEN . . .
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. ~ 1 . .
                       MIGHT CYCLE CTRL - CHILE CH AND
. 712 -
                       FAM-SCHEDULE . SI-FAMS
. . . .
+ 714 + UH-4 + SYSTEM
                        SYSTEM-TYPE = 1921
. 7:5 .
. 716 .
                       ZONE-NAMES * EMECHANICAL)
                       MAX-SUFTLY-T + 68 5
- 717 -
                       MIN-CUTSIDE AIR + 9 6
· ?18 •
. 7.2 .
                       HEATTHG-SCHEDING FENECH FOT A
• 770 •
                       HEATING-CAPACITY + -4000
• 721 •
. 722 . UH-5-8 . SYSTEM
                       SISTEMITINE - GAR
777
• 724 ·
                       JOHE-MAMES - LIEST CELL)
                       MAT-SUPPLY THE
• 725 •
• 726 •
                       HEATTING-SCHEDWIE EMECH HITS
. 777 -
                       HEATING-CAPACITY . - 136- ?
. 770 -
+ 729 + 5-2-3 + SYSTEM
• 130 •
                        gratem time a thick
• ::: •
                       ZONE-HAMES ELTEST CELL OF
• 777 •
                       MAXISTER FOR 124
                       Mid GREEFA L - eq
. 737 .
. 731 .
                       SUPPLY KW + (Y) A Y
• 735 •
                       MIN ATR-510 - MIN AIR!
                       HEATTHS-SCHETTINE HE HE TO
. :35 .
• 777 •
                       COOLITYS-SCHEDULE - MECHALICA
. .75 .
                       FAN-SCHEDINE - STIFTING
. ...
                       NIMITACAGLE CTR. + TABLE MY-ANA
                       STRILL DELIASE - 1.87
· *:5 ·
                       COULTNO-CAPACITE - 92100
. 41 -
. 7:2 -
                       HEATING-CAPACITY TO 1519/0
. ... .
+ 144 + UH-2 + SYSTEM
• 145 •
                       GISTEN TIPE # 1117
. - 15 .
                        ZONE MANES + (1070 - AUSO ON 1088)
. 147 .
                       MAY STEPLET & HIS
. "49 •
                       BURKELANG-SOURCESTON SERVICES
. .43 .
                       HEATING-CAPACITE = -3 174
• "Fŋ •
- IST . CH-1 - SISTEM
• 752 •
                       TATTEM TARE - 17
• 757 •
                        TONE-HAMES - (NORTH (CEAT)
. . .
                       MAR SEPPLIES - 147
• ===== •
                       HEATPIG-SCHOOL FEMERIE HE.
. 756 .
                       HEATING-CAPACITE + 535/VI
• *57 •
. TER . SYSTEMS-BERDRY
• 753 •
                       SUMMARY - (ALL-SUMMARY)
• 767) •
· 161 · BPT = HOUSELY-REFERE
• 153 •
                        | ₽£₽∁01-529€78 € - ₽₹₽ ₽₹
• 167 •
                        REPORT-BLOCK + 1+SUBSCNIP . +SHAP . +STA
. 75: •
. TES . . SUBSCRIC . REPORT-BLOCK
. 755 .
                         VARIABLE-TIPE - 5 850MIC
                        VAR(ABLE-LIST + (6.12.13)
• :ce •
. TEG . . SHOP . REPORT-PLOCK
• 770 •
                       VACIABLE-TIPE + SHOP
. . . .
                        VARIABLE-LIST + .6.12.11)
. 772 .
* 773 * *51 * REPORT-BLOCK
```

VARIABLE-TIPE + 51

```
VARIABLE-LIST + (1,2,4,53,19,20)

775 • FND ...

779 • COMPUTE SYSTEMS ...

781 • INSUT PLANT ...
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- 797 -
. 199 . ARS-COOL . PLANT-EQUIPMENT
                      THRE - APTORE-CHUR
. P4 .
705
                       SIZE # -999 ...
. 195 .
. THE . POT-MATER . PLANT EQUIPMENT
758
                       TIPE + ELFO-DHA-HEATER
• :83 •
                       SIZE - - 399 ...
. 776 .
+ 791 + *HEAT * LOAD-ASSIGNMENT
. 752
                       TAPE = MEATING
• 133 •
                       UD40-841/45 - 019
• 791 •
                       PLANT-EQUIPMENT & STILLTY
                       NUMBER = 999 ...
. 735 •
* 797 * LOAD-MANAGEMENT
• 755 •
                       PEED-(010 E401E - 900
                       LOAG-ASSIGNMENT = ( *HEAT, DEFAULT, DEFAULT)
· Pryry ·
. SCI . ENERGI-COST
• F(7 •
                       PERCURCE - STEAM
• P13 •
                       UNIT = 10000000
. 955 . PLANT-REPORT
                      SUMMARY . (PS-ALPS-RLPS-CLPS DLPS-GLPS HERE WIFEPS)
• 805 ·
• 907 -
• #18 • ENC .
• 953 •
. 810 . COMPUTE PLANT ...
. . .
• 812 • STOP ...
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55

APPENDIX B ECONOMIC ANALYSIS

I. ECONOMIC ANALYSIS OF ENERGY CONSERVATION OPPORTUNITIES

All proposed energy conservation opportunities (ECOs) were evaluated using the Department of Defense Energy Conservation Investment Program (ECIP) Guidance dated July 22, 1981. These guidelines require a two-part economic analysis consisting of a documented cost estimate and a life-cycle cost analysis for each alternative or combination of alternatives that constitute a project.

A. Economic Criteria

The economic criteria applied to each ECO are prescribed by the guidance as follows.

- 1. All projects must be cost effective, that is, Benefit/Cost Ratio $(B/C) \ge 1$.
- 2. All projects must produce an energy-to-cost ratio (E/C) equal to or greater than 15.
- All discrete portions of each project, that is ECOs, must meet both the E/C ratio minimum requirements and be life-cycle cost effective.
- 4. No more than 25% of the total annual savings shall be attributed to nonenergy sources.

B. Economic Parameters

We were instructed by the Air Force Academy to apply the same economic parameters as used for the FY 1983 ECIP submittals.

1. The short-term differential escalation rates applied to the end of the fiscil year in which construction was programmed were:

Design	6.0%
Construction	6.0%
Supervision, inspection, and overhead	6.0%
Fuel oil	14.00
Electricity	13.0%

2. The long-term differential escalation rates for computing the present worth of recurring annual costs/benefits were:

Maintenance and repair: O and M	0.0%
Fuel oil	8.0%
Electricity	7.0".

3. The discount factor to be applied to the present worth of recording annual costs/benefits was 10.

Fiel Costs

The Air Force provided us with the following FY 1981 bits fuel cost that we converted to FY 1984 fuel costs at the source.

Fuel oil:
$$\frac{(\$1.29/\text{gal.}) \times 10^6 \text{ Btu}}{(136,700 \text{ Btu/gal.})} = \$9.30/10^6 \text{Btu.}$$

Electricity:
$$\frac{(\$0.02468/kWn)(10^6 Btu)}{(3413 Btu/kWn)} = \$7.23/10^6 Btu.$$

When escalated to FY 1984, the fuel prices become

Fuel oil:
$$\frac{\$9.0}{10^6} \times (1.14)^3 = \$13.78/10^6$$
 Btu, and

Electricity:
$$\frac{\$7.23}{10^6} \times (1.13)^3 = \$10.44/10^6$$
 Btu;

when adjusted by the energy conversion factors* for fuel use at the souce,

Fuel oil:
$$$13.78/10^6$$
 Btu, and Electricity: $$10.44/10^6$ Btu x 3,413/11,600* = $$3.07/10^6$ Btu.

The latter rates are cost savings in FY 1984 dollars for every $10^6\,\mathrm{Btu}$'s saved at the source.

Although natural gas is consumed by the boilers supporting the high-temperature water distribution system, the Air Force Academy instruct dus to evaluate energy cost savings for the natural gas heating system on the basis of equivalent fuel oil prices and fuel oil escalation.

D. Methodology

The first step in the economic analysis of an ECIP project is to develop a Current Working Estimate (CWE). We were instructed by the Air Force Academy to develop this estimate by calculating the maximum amount of capital that

could be invested in a project to displace a unit of the fue and remain cost effective. The following outlines the calculation procedure for fuel hil and electricity, respectively.

1. Nonrecurring initial capital costs.

Construction bids (by definition F dollars)	= 1,0% P
Contingency at 15%	<u>- 0.15</u> P
Unescalated CWE	= 1.15 P
CWE escalated to end	
of FY 1984 = 1.15 (1.06) ³ P	= 1.37 P
Unescalated design at 15%	≈ 0.15 P
Design escalated to end	
of FY 1983 = 0.15 (1.06) ²	= 0.18 P
Salvage Value	= 0.00 P

2. Recurring costs.

Additional O and M at 3% = 0.03 P

3. Maximum capital investment. For fuel oil, one can afford to invest \$95.24 for each 10^6 Btu saved at the building boundary for projects with an economic life of either 15 or 25 years. For electricity, one can afford to invest \$103.85 and \$148.81 for each 10^6 Btu saved at the building boundary for projects with an economic life of 15 and 25 years, respectively. For fuel oil, the economic criterion that established the maximum investment is the E/C ratio = 15, and for electricity, the B/C ratio = 1.0. An example illustrates the development of the maximum capital investment.

Let us assume that a project has a CWE of £95.24 and displaces 1.0 x 10^6 Btu of fuel oil at the building boundary. Thus,

Design cost = 0.18 P =
$$(.18) \left(\frac{\$95.24}{1.37} \right)$$
 = \$12.56.
Salvage cost = 0.0 P = \$0.00.
O and M cost = 0.03 P = $(.03) \left(\frac{\$95.24}{1.37} \right)$ = \$2.09.

Inserting these costs into Fig. B=1 (the Form A=1 entitled "ECIE Economic Analysis Summary"), one can see that E/C = 15 and B/C > 1.0. If the CWE were larger than \$95.24, then E/C = 16. Thus, the maximum capital physicisment for fuel bill displacement of 10^6 Btu is established.

A similar calculation was performed for ECIP projects with fuel oil savings for 25 years and electrical energy savings for 15 and 25 years. Figures B-2 through B-4, showing these calculations, are attached.

The second step in the economic analysis of an ECIP project is the lifecycle cost evaluation. ECIP guidelines require that the E/C ratio be used in ranking projects and that projects must have a B/C ratio of 1.0 or greater. The B/C ratio is an index of the life-cycle cost effectiveness of a project as an investment apportunity. It shows the number of dollars that will be saved for each dollar that is invested in the project. The higher the B/C ratio, the more attractive the project. The E/C ratio shows the amount of energy savings in Btu x 10^6 (MBtu) per \$1000 of project cost. The E/C ratio ensures that projects will be prioritized by the criterion of greatest energy savings per investment dollar. Another project comparison index is the payback period, which is determined by dividing the annual cost savings into the CWE. The payback period is not involved in project ranking but is included because it is a familian evaluation index. The life-cycle cost is determined by adding the discounted benefits and costs of a project over its life to the project's implementation cost. The procedure for olaluating life-cycle cost is shown in Figs. B-1 through B-4 (the Form A-1, "ECIP Economic Analysis Summary"). The life-cycle costing results for the proposed ECIP projects are summarized in the next section.

II. SUMMARY OF LCONOMIC RESULTS

A summary of the economic results is provided in Tables B-I through B-VI.

III. DOCUMENTATION OF ECONOMIC ANALYSIS

The documentation for the economic analysis of the ECIP projects proposed for Vandenberg Hall, the Field House, and the Aeronautics Laboratory is attached as pages 93-123.

Fig. 5-1

FORM 4-1 ECIP ECONOMIC ANALYSIS SUMMARY

Location: Calarena Species	PY CA
Project: A Free & Alexander	of the state of th
Economic Life: 15 Yrs. Date Prepared 1/27 Prepared by	
COSTS	
1. Non-recurring Initial Capital Costs:	_
a. CNI	9E 24
b. Design C. Salvene	
d. Total	
BENEFITS	*
Recurring Benefit/Cost Differential Other Than Energy:	_
a. Annual Labor Decrease (+)/Increase (-)	-2 09 /Yr.
 b. Annual Material Decrease (+)/Increase (-) c. Other Annual Decrease (+)/Increase (-) 	<u> </u>
d. Total Costs	-2.63 /YE.
e. 10% Discount Factor	20060
f. Discounted Recurring Cost (d x e)	- 1 (c .in En
3. Returning Energy Benefit/Costs:	
a. Type of Fuel	, ∧≃ Metu
(2) Cost per MSTU	S THE THETU
(3) Annual Dollar Decrease/Increase ((1)x(2))	Yr.
(4) Differential Escalation Rate (1) Factor	
(5) Discounted Dollar Decrease/Increase(3)x(4) b. Type of Fuel:	. 52.16
b. Type of Fuel:(1) Annual Energy Decrease (+)/Increase (-)	MBTU
(2) Cost per Matu	\$ /MBTU
(3) Annual Dollar Decrease/Increase ((1)X(2))	\/\r.
(4) Differential Escalation Rate (
(5) Discounted Dollar Decrease/Increase ((3)x(4)) C. Type of Fuel:	3
(1) Annual Energy Decrease (+)/Increase (-)	₩BTU
(2) Cost per MBTU	\$ /MBTU
(3) Annual Dollar Decrease/Increase ((1)x(2))	\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\
(4) Differential Escalation Rate (%) Factor (5) Discounted Dollar Decrease/Increase ((3)x(4))	•
(5) Discounted Dollar Decrease/Increase ((3)x(4)) d. Type of Fuel:	
(1) Annual Energy Decrease (+)/Increase (-)	_ MBTU
(2) Cost per MBTU	\$ /MBTU
 (3) Annual Dollar Decrease/Increase ((1)x(2)) (4) Differential Escalation Rate (\$)Factor 	\$/Yr.
 (4) Differential Escalation Rate (_\$)Factor (5) Discounted Dollar Decrease/increase ((3)x(4)) 	
(5) Discounted Dollar Decrease/increase ((3)x(4))	
e. Discounted Energy Benefits (3a(5)+3b(5)+3c(5)+3d(5)) 4. Total Benefits (5un 2f+3e)	4 1 2 1
5. Discounted Benefit/Cost Ratio (Line 4+Line ld)	2, 4
6. Total Annual Energy Savings (30(1)+3b(1)+3c(1)+3d(1))	1.42 MF/ 11
7. E/C Ratio (Line 5 + Line la/1000)	15.0
 Annual & Savings (2d+7a(3)+3b(3)+3c(3)+3d(3)) Pay-back Period ((Line la - Salvage)+Line B) 	1 <u>. 17. 6</u> .0 2 5. 4 .1 30.2
10. Lite Cycle Cout (Line 14-21-20)	- 3 (7.3 74
JP: Little (induite Citicate (indicate Admixinate)	

Fig. B-2

FORM A-1 FOIF ECONOMIC ANALYSIS SUMMARY

onomic Life: 2 - Yrs. Date Prepared 9/c. Prepared by	Himilia de de la companya del companya del companya de la companya
	T:P
<u>sus</u>	
hon-recurring Initial Capital Costs: a. CKE	
b. Design	1/- 24
E. <u>Sandara</u> , €	
d. Total	
NEFITS:	\$ 15 TY
Recurring Benefit/Cost Differential Other Than Energy:	
a. Annual Labor Decrease (+)/Increase (-)	\$ - 7 9 /Yr.
b. Annual Material Decrease (+)/increase (-)	\$ /YF
c. Other Annual Decrease (+)/Increase (-)	\$/Yr.
d. Total Costs	- 2. (1) /Yr.
e. 10: Discount Factor	5 564
f. Discounted Recurring Cost (d x e)	\$ = 0.0 G 1
Recurring Energy Benefit/Costs:	
a. Type of Fuel: Evel oil	
(1) Annual Energ. Decrease (+)/Increase(-)	1.43 PETU
(2) Cost per MSTU	I F I F /MSTU
(3) Annual Dollar Decrease/Increase ((1)x(2)) (4) Differential Escalation Rate (5 %) Factor	11.69 /Yr.
(4) Differential Escalation Rate (A) Factor (5) Discounted Dollar Decrease/Increase(3)x(4)	20050
b. Type of Fuel:	\$ 41/4.7F
(1) Annual Energy Decrease (+)/Increase (-)	_ MBTU
(2) Cost per MBTU	\$ /MBTU
(3) Annual Dollar Decrease/Increase ((1)X(2))	\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\
(4) Differential Escalation Rate (1) Factor	
(5) Discounted Dollar Decrease/Increase ((3)x(4))	\$
C. Type of Fuel:	
(1) Annual Energy Decrease (+)/Increase (-)	MBTU_
(2) Cost per MBTU	MBTU
(3) Annual Dollar Decrease/Increase ((1)x(2))	\$Y
(4) Differential Excelation Rate (_B) Factor	
(5) Discounted Dollar Decrease/Increase ((3)x(4)) d. Type of Fuel:	-
(1) Annual Energy Decrease (+)/Increase (-)	A40-11
(2) Cost per MBTU	MBTU
(3) Annual Dollar Decrease/Increase ((1)x(2))	Mayu
(4) Differential Escalation Rate (%)Factor	\$
(5) Discounted Dollar Decrease/Increase ((3)x(4))	
e. Discounted Energy Benefits (3a(5)+3b(5)+3c(5)+3d(5))	3914.71
Total Benefits (Sun 2f+3e)	74.0
Discounted Benefit/Cost Ratio (Line 4.Line 1d)	3.48
Total Annual Energy Savings $(3a(1)+3b(1)+3c(1)+3d(1))$	1.4.1
E/C Ratio (Line 6 + Line la/1000)	15,0
Annual \$: Savings (2d+3a(3)+3b(3)+3c(3)+3d(3))	\$ 17. mc/
	· · · · · · · · · · · · · · · · · · ·
Pay-back Period ((Line la - Salvage)+Line 8)	<u>5.41</u> y

Fig. B-3

FORM A-1 ECIP ECONOMIC ANALYSIS SUMMARY

cation oject	: Colerado Aus Forco			N_ c 4-
	Life Yrs.	Date Prepared	Prepared by	<u></u>
375	recurring Initial	Canital Costs:		
	CHE	capital water.		\$ 105 85_
b .	Design			12 FF
C.	Salvage			\$
d.	Total			\$ <u>_117_</u> 40
NEFITS Reci		t Differential Other	Than Engrave	
A .		rease (+)/Increase (-		\$ (2.27) /Yr.
		Decrease (+)/Increase		S Q /Yr.
		rease (+)/increase (-		S C /Yr.
đ.	Total Costs			\$ 2 2 7 /YF.
_	101 Discount Fact			7.7.
f.	Discounted Recurr			115.u5)
Reci	urring Energy Bene Type of Fuel <u>: =</u>			
•,	(1) Annual Energ	v Decrease (+)/incre	Ase(-)	3.40 PETU
	(2) Cost per MB			\$ - : - /HETU
		r Decrease/Increase	((1)x(2))	\$ 11.54 /Yr.
		l Escalation Rate 🕻		12 727
		Dollar Decrease/Incre	ase(3)x(4)	\$/ <u>=5,65</u>
٥.	Type of Fuel:		 / \	ero Tu
		cy Decrease (+)/Incre	1876 (-)	S PARTU
	(2) Cost per M8' (3) Annual Dolla	r Decrease/Increase	((1)1/2))	/\r.
	(4) Differentia	l Escalation Rate (_	S) Factor	~
	(5) Discounted (Dollar Decrease/Incre	ase ((3)x(4))	\$
C.	Type of Fuel: _			
		gy Decreese (+)/Incre	1436 (-)	MBTU
	(?) Cost per MB	טז	1103 1033	MBTU
,		ar Decrease/Increase		\$
		l Escalation Rate (_ Dollar Decrease/Incre		•
đ.	(5) Discounted Type of Fuel:	WITE DELIVERED LANGE	((-/^(7//	T
٠.	()) Annual Ener	gy Decrease (+)/Incm	1858 (-)	MBTU
	(2) Cost per MB	TU		\$ /Maiu
	(3) Annual Doll	ar Decrease/Increase	((1)x(2))	\$Yr.
	(4) Divierentia	l Escalation Rate (_	S)Factor	
	/8/ Bibeas			<u> </u>
•	Discounted frem	y Benefits (3a(5)+3b	(5)+3c(5)+3d(5))	125
Tot	al Benefits (Sum	21+3e) ost Ratio (Line 4+L:	Inn 141	مينيده
Dis Tot	counted senetit/L	Savings (3a(1)+3b(1)	ine 10)	
	Ratio (Line 6 +		. 20/1/. 20/1/	22.74
Ann	ual & Savings (2d	+3a(3)+3b(3)+3c(3)+3c	d(3))	8 7
Pay	-back Period ((L1	ne la - Salvage)+Lini	R B)	11.04
4	de conte com	+ (Line 1d - s+ -	26)	<u> </u>

FORM A-1 ECIP ECONOMIC ANALYSIS SUMMARY

Location: Co		Francis .		N =4
Economic Life:	F14-51 /- E	Date Prepared 10	F/ Prepared by_	01112
e. CNE b. Design	_	Capital Costs:		14P.F1 19 41
d. Total RENEFITS 2. Recurring a. Annua b. Annua c. Other	Benefit/Coss Labor Decri Material Decri	t Differential Other case (+)/Increase (- ccrease (+)/Increase case (+)/Increase (-) (-)	(3.26) /Yr. 2.60 /Yr. 2.60 /Yr.
f. Disco 3. Recurring a. Type (1) (2)	iscount facti unted Recurr Energy Bene of Fuel: El Annual Energ Cost per MBT	ing Cost (d x e) fit/Costs: ectricity Decrease (+)/Incre		2 40 PETU 2 10 /51U 11 04 (VI)
(4) (5) b. Type (1) (2) (3)	Differential Discounted D of Fuel: Annual Energ Cost per MBT Annual Dolla	Escalation Rate (plar Decrease/Incre y Decrease (+)/Incre	1 1) Factor PASE (3) x (4) EASE (-) ((1) x (2))	MBTU /MBTU /MBTU /IT.
c. Type (1) (2) (3) (4) (5)	of Fuel: Annual Enero Cost per MBi Annual Dolla Differential Discounted D	ollar Decrease/Inch y Decrease (*)/Inch U In Derrease/Increase Escalation Rate (bollar Decrease/Inch	((1)x(2); 3) Factor	MBTU /MBTU /Yr.
(1) (2) (3) (4) (5) •. Disco	Cost per MBi Annual Dolla Differential Discounted Energy	ir Decrease/Increase Escalation Mate (_ 	((1)x(2)) S)Factor gase ((3)x(4))	MBTU /MBTU /Yr. // / / / / / / / / / / / / / / / / / /
5. Discounte 8. Total And 7. E/C Ratio 8. Annual S 9. Pay-back	nual Energy S o (Line 6 + L Savings (2d Period ((Li	set Ratio (Line 4.) savings (3a(1)+3b(1), line 1a/1000) 5a(3)+3b(3)+3c(3)+3 ne 1a - Salvage)+Lin - (Line Id - &f	+3c(1)+3d(1)) d(3)) e B)	1.5 yrs

TABLE B-I

		Estimated Energy_Use	⁵ Energy	Annual	imated Savings	10 ⁶ Btu Saved per \$1000	Maximum Investment	Discounted Benefit/	Life-Cycle Cost
_	Option	(Btu/ft²/yr)	Reduction	<u>51,000</u>	10 ⁶ 8tu	<u>lnvested</u>	(5)	Cost Ratio	(\$1,000)
1.	Baseline, as-built	120,834				-			
2.	Reinstate economizer	120,369	1	1	354	36.5	11,023	1.000	9
3.	Zone thermostats for baseboard heaters	116,661	4	34	3,172	15.0	236,612	1.959	-227
4.	Tunnel preheat of ventilation air	116,944	3	36	2,956	15.0	222,717	3.410	-537
5.	Reinstate radiant heating	118,961	2	1	1,423	215.7	7,463	1.000	0
6.	Run-around heat recovery loop	94,320	22	242	20,152	15.0	1,517,967	3.396	-3,638
7.	Minimize ventilation rates	103,350	15	160	13,287	15.0	1,001,360	3.413	2,417
3.	Improve fam/motor efficiencies	114,637	5	10	4,710	24.2	220,150	1.000	0
9.	Night insulation on windows	119,902	1	9	708	15.0	53,342	3.410	-150
10.	Improve wall and roof insulation	120,532	1	3	229	15.0	17,068	4.114	-53
iI.	Combine options 6 and 7	90,887	25	274	22,764	15.0	1,715,586	3.398	. 1111
12.	Combine options 6, 7, and 8	84,681	30	284	27,475	16.0	1,935,966	3,125	-4.111
13.	Combine options 6, 7, 8, and 2	84,217	30	284	27,925	16.1	1,947,726	3.114	=4,137
14.	Combine options 6, 7, 8, 2, and 3	81,730	32	301	29,770	15.4	2,184,332	2.951	1,763

2. Solar OHW system

TABLE 8-11
ECONOMIC SUMMARY OF SOLAP OPTIONS FOR VANDENBERG HALL

		Estimated			imated Savings	In ⁶ Rtu Saved	Max imum	Discounted	Life-Cycle
	Option	Energy Use (Btu/ft ² /yr)	2 Energy Reduction	\$1,000	10 ⁶ Btu	per \$1090 Invested	Investment(\$)	Benefit/ Cost Ralio	(65) (81,000)
٠.	Baseline, as-built	120,834							-
2.	Solar DHW system	114,042	6	67	5,152	15.0	390,192	3.636	-1,070
				TA	PLE 8-111				
		ECONO	MIC SUMMARY OF	ENERGY C	DNSERVATIO:	N OPTIONS FOR FIELD) HOUSE		
		Estimated Energy Use	: Energy	-	mated Savings	10 ⁶ Btu Saved per \$1000	Maximum Investment	Discounted Renefit/	Life i yola Cort
	Option	(Btu/ft ² /yr)	Reduction	\$1,000	10 ⁶ Btu	Invested	(\$)	Cost Ratio	(ii',iii)
1.	Baseline	188,281							
2.	Htility tunnel heat recovery	145,432	23	139	10,543	15.0	795,214	3.479	-1,971,176
3.	Peduce thermostat setting	169,976	10	48	4,750	15.0	358,273	1.854	ا عن و الم
4.	Add roof insulation	181,221	4	19	1,737	15.0	131,015	3.039	= 767 , 026
5.	Combine options 2 and 3	134,011	29	158	13,353	15.0	1,007,161	3.354	_2_17n_an1
6.	Combine options 2, 3, and 4	127,850	32	174	14,859	15.0	1,121,506	3.317	_2,5an,an2
				TA	BLE R-IV				
			ECONOMIC SUM	MARY OF S	OLAR OPTIO	VS FOR FTELD HOUSE			
	Option	Estimated Evergy Use (Btd/ft2/yr)	T Emergy Reduction	Annua?	nated Savings 10 ⁶ Btu	10 ⁵ 8th Saved per \$1000 Invested	Maximum Investment (\$)	Discounted Ronefit/ Cost Ratio	ljifa.fygle Torr (≸), mby
 1.	Baseline	158,291							

7 271

15.0

20,44]

6.779

116 017

107,190

<u> 1</u>

TABLE B-V

ECONOMIC SUMMARY OF ENERGY CONSERVATION OPTIONS FOR AERONAUTICS LABORATORY

Option		Esti ≡ ated	≝ [nergy		mated Savings	10 ⁶ Btu Saved	Max i mum	Viscounted	Life Cycle
		Energy Use (Btu/ft ² /yr)		\$1,000	10 ⁶ 8tu	per \$1000 Invested	Investment (\$)	Benefit/ Cost Ratio	Cost (\$ 1,000)
1.	Baseline, as-built	446,448							
2.	Adjusted baseline	462,845	-						
3.	Seasonal heating and cooling	450,826	3	3	302	15.0	22,778	2.059	-24
4.	Night setback in lobbies	460,896	1	1	49	15.0	3,695	2.666	6
5.	Demand control	447,244	3	5	392	15.0	29,567	2.261	-37
6.	Evaporative cooling	469,612	-1	0	-170				
7.	Combine options 3 and 5	440,00G	5	7	574	15.0	43,294	2.169	-51
8.	Combine options 3, 5, and 6	408,756	12	15	1,359	15.0	102,504	3.162	222

TABLE B-V1

ECONOMIC SUMMARY OF SOLAR OPTIONS FOR AERONAUTICS LABORATORY

	Option	Estimated Energy Use (Btu/ft ² /yr)	₹ Energy Reduction		mated Savings 10 ⁶ Btu	10 ⁶ Btu Saved per \$1000 Invested	Maximum Investment (%)	Discounted Benefit/ Cost Ratio	Life-Cycle Cost (\$1,000)
1.	Adjusted baseline	462,846							
2.	Daylighting	445,692	4	1	431	108.6	4,489	1.0	(I
3.	Trombe wall	452,896	2	3	250	15.0	18,857	2.846	~35
4.	Sunspace for test cell classrooms	460,856	1	1	50	15.0	3,771	3.244	· 8
5.	Active solar heating 6,000 ft ² , 10,800 gal.	423,920	8	13	978	15.0	73,766	3.640	195
6.	Solar DHW, 120 ft ² , 215 gal.	461,134	1	0	43	24.1	2,021	1.000	ı)

Cation: Contest and Expense as a figure	<u> </u>
ojest: vande berg Hall	
conomic Life: 15 Yrs. Date Prepared 7/82 Prepared by	
SYS	
Non-recurring Initial Capital Costs:	
a. CWI	\$ 17.696
b. Design	\$ 1327
c. Calvage	
d. Total	11 023
EFITS.	
Recurring Banefit/Cost Differential Other Than Energy:	A A
a. Annual Labor Decrease (+)/Increase (-)	- 219 1Yr.
b. Annual Material Decrease (+)/Increase (-)	/Yr.
C. Other Annual Decrease (+)/Increase (-)d. Total Costs	/YF.
e. 30% Discount Factor	- 219 /Yr.
f. Discounted Recurring Cost (d x e)	
Recurring Energy Benefit/Costs:	= 1748
a. Type of fuel: much coll	
(1) Annual Energy Decrease (+)/Increase(-)	4.5 M STU
(2) Cost per MSTU	\$ 12 72 /Matu
(3) Annual Dollar Decrease/Increase ((1)x(2))	\$ - 5 FT 112 / 1 F.
(4) Differential Escalation Rate (# %)Factor	12.112
(5) Discounted Dollar Decrease/Increase(3)x(4)	\$ - 7 . 3
b. Type of fuel: primary and a	•
(1) Annual Energy Decrease (+)/Increase (-)	MBTU MBTU
(2) Cost per MBTU	3.07 /MBTU
(3) Annual Dollar Decrease/Increase ({1})X(2)) (4) Differential Escalation Rate (7/2 %) Factor	1099 /Yr.
(4) Differential Escalation Rate (7/8) Factor (5) Discounted Dollar Decrease/Increase ((3)x(4))	12 2 F
c. Type of Fuel:	13,494
(1) Annual Energy Decrease (+)/Increase (-)	MBTU
(2) Cost per MBTU	\$
(3) Annual Dollar Decrease/Increase ((1)x(2))	\$
(4) Differential Escalation Rate (_3) Factor	
(5) Discounted Dollar Decrease/Increase ((3)x(4))	3
d. Type of Fuel:	
(1) Annual Energy Decrease (+)/Increase (-)	MBTU
<pre>(2) Gost per MBTU (3) Annual Dollar Decrease/Increase ((1)x(2))</pre>	\$ /MBTU
(3) Annual Dollar Decrease/Increase ((1)x(2))	\$Yr.
(4) Differential Escalation Rate (8) Factor	
(5) Discounted Dollar Docrease/Increase ((3)x(4))	
 Discounted Energy Benefits (3a(5)+3b(5)+3c(5)+3d(5)) 	1-377/
Total Benefits (Sun 2f+3e)	ع المحتمد المح
Discounted Benefit/Cost Ratio (Line 4-Line 1d)	1,000
Total Annual Energy Savings (3a(1)+3b(1)+3c(1)+3d(1)) E/C Ratio (Line 6 + Line la/1000)	-354 M
Annual \$ Savings (2d+3a(3)+3b(3)+3c(3)+3d(3))	36.5
Pay-back Period ((Line la - Salvage) (Line B)	\$ <u>_825</u>
	<u> </u>
Life - Cycle Cout (Line Id + 54 - 50)	4

Project: Vandentes	Hall Co	N 54
Economic Life:15 Yrs.	Date Prepared 9/62 Prepared by	5UP
T. Non-recurring Initial C a. CNI b. Design c. Sulunge d. Total	apital Costs:	211 467 25 145 5
BENEFITS: 2. Recurring Benefit/Cost a. Annual Labor Decrea	rease (+)/Increase (-) se (+)/Increase (-) g Cost (d x e) t/Costs:	-4 19 1 /Yr. - 0 /Yr. - 0 /Yr. - 0 /Yr. - 19 1 /Yr. - 19 1 /Yr. - 1.960
(1) Annual Energy (2) Cost per MBTU (3) Annual Dollar (4) Differential E (5) Discounted Dol b. Type of Fuel: Elc (1) Annual Energy (2) Cost per MBTU	Decrease (+)/Increase(-) Decrease/Increase ((1)x(2)) scalation Rate (= 5)Factor lar Decrease/Increase(3)x(4)	2,639 METU 2,72 /METU 26,365/Yr. 13,117 470,518 523 METU 3,07 /METU
(4) Differential E (5) Discounted Dol C. Type of Fuel: (1) Annual Energy (2) Cost per MBTU (3) Annual Dollar (4) Differential E	Decrease (+)/Increase (-) Decrease/Increase (-) Decrease/Increase ((1)x(2)) scalation Rate (_B) Factor lar Decrease/Increase ((3)x(4))	1656 111. 12.278 20.086 MBTU /MBTU /YF.
(1) Annual Energy (2) Cost per MBTU (3) Annual Dollar (4) Differential E (5) Discounted Dol e. Discounted Energy B 4. Total Benefits (Sum 2f+ 5. Discounted Benefit/Cost 6. Total Annual Energy Sav 7. E/C Ratio (Line 6 + Lin 8. Annual S Savings (2d+3a 9. Pay-back Period ((Line	Ratio (Line 4:Line 1d) lings (3a(1)+3b(1)+3c(1)+3d(1)) le la/1000) l(3)+3b(3)+3c(3)+3d(3)) la - Salvage)+Line 8)	MBTU /MBTU /Yr. /Yr. 446,464 463,460 1.959 3172 N.BA 15.0 33.B.10 6.253-
10. Life-cycle coul	(Line 1d-21-20)	s - 226,84 B

Location: Calamada Spaninger, de	N E4
Transco Present of Ventilation Air	
Econumic Life: 25 Vrs. Date Prepared 4 /82 Prepared by	y TLP
CCSYS	
1. Non-recurring Initial Capital Costs:	
a. CHE	197,067
b. Design c. <u>Sankagare</u>	25,650
d. Total	222 717
BENEFITS	
Recurring Benefit/Cost Differential Other Than Energy:	A
a. Annual Labor Decrease (+)/increase (-)	\$ -4 274 /Yr.
 b. Annual Material Decrease (+)/Increase (-) c. Other Annual Decrease (+)/Increase (-) 	9 /YF.
d. Total Costs	-4.274 /YF.
e. 10: Discount Factor	9 524
f. Discounted Recurring Cost (d x e)	\$ - 40,706
3. Recurring Energy Benefit/Costs: a. Type of Fuel: ニテムウリニング	
(1) Annual Energy Decrease (+)/Increase(-)	266/ PETU
(2) Cost per MSTU	\$ 7 7 /M51U
(3) Annual Dollar Decrease/Increase ((1)x(2))	\$ 74 705 /Tr.
(4) Differential Escalation Rate (লুছ)Factor (5) Discounted Dollar Decrease/Increase(3)x(4)	\$ 746 466
b. Type of Fuel:	•
(1) Annual Energy Decrease (+)/Increase (-)	<u> </u>
(2) Cost per MBTU	S 3.07 MBTU
(3) Annual Dollar Decrease/Increase ((1)X(2))	\$ 236 /Yr.
(4) Differential Escalation Rate (71%) Factor (5) Discounted Dollar Decrease/Increase ((3)x(4))	\$ 4.151
c. Type of Fuel:	
(1) Annual Energy Decrease (+)/Increase (-)	MBTU
(2) Cost per MBTU	/MBTU
(3) Annual Dollar Decrease/Increase ((1)x(2)) (4) Differential Escalation Rate (%) Factor	\$Yr.
(5) Discounted Dollar Decrease/Increase ((3)x(4))	3
d. Type of Fuel:	
(1) Annual Energy Decrease (+)/Increase (-)	PIBTU
(2) Cost per MBTU	/MBYU
(3) Annual Dollar Decrease/Increase ((1)x(2)) (4) Differential Escalation Rate (S)Factor	•
(5) Discounted Dollar Decrease/Increase ((3)x(4))	
 Discounted Energy Benefits (3a(5)+3b(5)+3c(5)+3d(5)) 	200,136
4. Total Benefits (Sum 27+3e)	<u>759.</u> 430
5. Discounted Benefit/Cost Ratio (Line 4-Line 1d)	3,410 2,456-Mble
 Total Annual Energy Savings (3a(1)+3b(1)+3c(1)+3d(1)) E/C Ratio (Line 6 + Line 1a/1000) 	
8. Annual & Savings (2d+3a(3)+3b(3)+3c(3)+3d(3))	<u>35 656</u>
9. Pay-back Period ((Line la - Salvage)+Line B)	<u> </u>
10. Life - Cycle Coal (Line 10 - 2f - Be)	\$ -536 713
101 21-6-103111 (2111-6)	······································

Location: Colorado Springs Cc	TY BZ
Project: Vander pera Hall Remotate Radiont Heating	
Economic Life: 25 Yrs. Date Prepared 4/42 Prepared by	TLP
TOSTS 1. Non-recurring Initial Capital Costs:	
a. CKE	6 5 1 6
b. Design c. Solvage	
d. Total	1,463
BENEFITS' 2. Recurring Benefit/Cost Differential Other Than Energy:	,
a. Annual Labor Decrease (+)/Increase (-)	\$ - 144 /Yr.
b. Annual Material Decrease (+)/Increase (+)	ο /Yr.
c. Other Annual Decrease (+)/Increase (-)	3-144 /Yr.
d. Total Costs e. 10: Discount Factor	9.52.4
 f. Discounted Recurring Cost (d x e) 	-/372
3. Recurring Energy Benefit/Costs: a. Type of Fuel: Fuel Oil	
(1) Annual Energy Decrease (+)/Increase(-)	- 3/7 PETU
(2) Cost per M57U	13.75 /MBTU
(3) Annual Dollar Decrease/Increase ((1)x(2)) (4) Differential Escalation Rate (2 %)Factor	\$-4,36E /Yr. 20.050
(5) Discounted Dollar Decrease/Increase(3)x(4)	-87 57E
b. Type of Fuel: Electricity	, 740 MBTU
(1) Annual Energy Decrease (+)/Increase (-) (2) Cost per MBTU	S 2 07 /MBTU
(3) Annual Dollar Decrease/Increase ((1)X(2))	\$ 5.34% /Yr.
(4) Differential Escalation Rate (7 %) Factor	\$ 76.44
(5) Discounted Dollar Decrease/Increase ((3)x(4)) c. Type of Fuel:	•
(1) Annual Energy Decrease (+)/Increase (-)	MBTU
(2) Cost per MBTU	/MBTU
(3) Annual Dollar Decrease/Increase ((1)x(2)) (4) Differential Escalation Rate (3) Factor	•
(5) Discounted Dollar Decrease/Increase ((3)x(4))	8
d. Type of Fuel:	MBTU_
(1) Annual Energy Decrease (+)/Increase (-) (2) Cost per MBTU	\$ /MBTU
(3) Annual Dollar Decrease/Increase ((1)x(2))	\$
(4) Differential Escalation Rate (3) Factor	
(5) Discounted Dollar Decrease/Increase ((3)x(4)) e. Discounted Energy Benefits (3a(5)+3b(5)+3c(5)+3d(5))	8.840
A. TOTAL MANATITE (SUM) ZTTJE)	▼
5. Discounted Benefit/Cost Ratio (Line 4-Line 1d)	1.000 1.423 metu
6. Total Annual Energy Savings (3a(1)+3b(1)+3c(1)+3d(1)) 7. E/C Ratio (Line 6 + Line 1a/1000)	315.7
A. Annual & Savings (2d+3a(3)+3b(3)+3c(3)+3c(3)+3c(3))	\$ 820
 Pay-back Period ((time la - Salvage)*Line o) 	الم المستقالة المستقال المستقالة المستقالة المستقالة المستقالة المستقالة المستقالة الم
10. Life-Cycle Cost (Line 1d-21-3e)	<u> </u>

Project: Vandeniena Hall	N 195.4
Economic Life: 25 Vrs. Date Prepared 2/22 Prepared by	7: 2
TOSTS T. hon-recurring Initial Capital Costs:	
a. CWI b. Design	1342 667
6. <u></u>	174 50C
d. Total BENEFITS	1,5., 767
 Recurring Benefit/Cost Differential Other Than Energy: Annual Labor Decrease (+)/Increase (-) 	\$-29.08 = /Yr.
b. Annual Material Decrease (+)/Increase (-)	\$
C. Other Annual Decrease (+)/Increase (-)d. Total Costs	
 e. 10: Discount Factor f. Discounted Recurring Cost (d x e) 	9.524
3. Recurring Energy Benefit/Costs:	-176,986
(1) Annual Energy Decrease (+)/Increase(-)	14.540 MIU
(2) Cost per MSTU(3) Annual Dollar Decrease/Increase ((1)x(2))	13.72 /KBTU 164,261/Tr.
(4) Differential Escalation Rate (⊆ x)Factor	20,000
b. Type of Fuel: Stanfricity	5.395, 6 F.3
(1) Annual Energy Decrease (+)/Increase (-)(2) Cost per MBTU	6/2 MBTU \$ 3.07 /MBTU
(3) Annual Dollar Decrease/Increase ((1)x(2))	\$ 1472 /Yr.
(5) Discounted Dollar Decrease/Increase ((3)x(4))	\$ 32 114
C. Type of Fuel: (1) Annual Energy Decrease (+)/Increase (-)	MBTU
(2) Cost per MBTU	\$ /MBTU
(4) Differential Escalation Rate (3) Factor	\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\
(5) Discounted Dollar Decrease/Increase ((3)x(4)) d. Type of Fuel:	
(1) Annual Energy Decrease (+)/Increase (-)	MBTU
(2) Cost per MBTU(3) Annual Dollar Decrease/Increase ((1)x(2))	/MBTU
 (4) Differential Escalation Rate (_%)Factor (5) Discounted Dollar Decrease/Increase ((3)x(4)) 	
 Discounted Energy Benefits (3a(5)+3b(5)+3c(5)+3d(5)) 	5,432,597
4. Total Benefits (Sum 2f+3e) 5. Discounted Benefit/Cost Ratio (Line 4+Line 1d)	3.396
 Total Annual Energy Savings (3a(1)+3b(1)+3c(1)+3d(1)) 	20 152 Mel
7. E/C Ratio (Line 6 ÷ Line la/1000) 8. Annual \$ Savings (2d+3a(3)+3b(3)+3c(3)+3d(3))	\$.42 057
P. Pay-back Period ((Line la - Salvage):Line B)	5.55 yr 3 - 3 627,644
io. Life - eyele cont (Line 1d-24-3e)	- 3,651,673

	ation: Colorado Springs	N 54
Pr	Jest: Vandenberg Houll Minimite Ventilanden Bares	
Eco	nomic Life: 25 Yrs. Date Prepared 4/pg Prepared by	TP
10	Non-recurring Initial Capital Costs:	
••	a. CKI	\$ PED 844
	b. Design	115 E16
	c. Salvage	
	d. Total	11001360
	EFITS	
2.	Recurring Benefit/Cost Differential Other Than Energy: a. Annual Labor Decrease (+)/Increase (-)	
	b. Annual Material Decrease (+)/Increase (-)	-19 395 /Yr.
	C. Other Annual Decrease (+)/Increase (-)	\$
	d. Total Costs	-1924 /Yr.
	E. 101 Discount Factor	4 5 2.A
3.	f. Discounted Recurring Cost (d x e)	<u>-154</u> , 74 7
J.	Recurring Energy Benefit/Costs: a. Type of Fuel: Fuel Oil	
	(1) Annual Energy Decrease (+)/Increase(-)	i enn Petu
	(2) Cost per MBTU	\$ 1276 /MSTU
	(3) Annual Dollar Decrease/Increase ((1)x(2))	THE ALL YE.
	(4) Differential Escalation Rate (FX)Factor	22,050
	(5) Discounted Dollar Decrease/Increase(3)x(4) b. Type of Fuel: Electricity	\$ 2 ESE 401
	(1) Annual Energy Decrease (+)/Increase (-)	_3/0 MBTU
	(2) Cost per Matu	\$ 7MBTU
	(3) Annual Dollar Decrease/Increase ((1)X(2))	Yr.
	(4) Differential Escalation Rate (7 %) Factor	18.249
	(5) Discounted Dollar Decrease/Increase ((3)x(4))	17 160
	(1) Annual Energy Decrease (+)/Increase (-)	MBTU
	(2) Cost per MBTU	\$
	(3) Annual Dollar Decrease/Increase ((1)x(2))	/Yr.
	(4) Differential Escalation Rate (_X) Factor	
	(5) Discounted Dollar Decrease/Increase ((3)x(4))	
	d. Type of Fuel: (1) Annual Energy Decrease (+)/Increase (-)	AM Tu
	(2) Cost per MBTU	MBTU /MBTU
	(3) Annual Dollar Decrease/Increase ((1)x(2))	1 /YF.
	(3) Annual Dollar Decrease/Increase ((1)x(2)) (4) Differential Escalation Rate (_X)Factor	Variation and the second
	(5) Discounted Dollar Decrease/Increase ((3)x(4))	
	e. Discounted Energy Benefits (3a(5)+3b(5)+3c(5)+3d(5))	7 60 45 5 B
4. 5.	Total Benefits (Sum 2f+3e) Discounted Benefit/Cost Ratio (Line 4+Line 1d)	3 417, 824
Ğ.	Total Annual Energy Savings (3a(1)+3b(1)+3c(1)+3d(1))	3.67
Ž.	E/C Ratio (Line 6 + Line 1a/1000)	12 267 NEHL
į.	Annual \$ Savings (2d+3a(3)+3b(3)+3c(3)+3d(3))	\$ 160.377
♥.	Pay-back Period ((Line la - Salvage):Line B)	5.52 y~
	Life-cycle Coct (Line 1d-2f-3e)	3 - 2,416,476
10.	Circi-ogeie Copi (1. 15 12	

Some recurring Initial Capital Costs: a. CNE	ocation				η
Non-recurring Initial Capital Costs: a. CNE b. Design C.	Liei	ere Far / Le-	Date Prepared 1/62	Prepared by	ELF
a. CNE b. Design C. Total ENEFITS Recurring Benefit/Cost Differential Other Than Energy: a. Annual Labor Decrease (+)/Increase (-) b. Annual Material Decrease (+)/Increase (-) c. Other Annual Decrease (+)/Increase (-) d. Total Costs e. 101 Discount Factor f. Discounted Recurring Cost (d x e) Recurring Energy Benefit/Costs: a. Type of Fuel: (1) Annual Energy Decrease (+)/Increase (-) (2) Cost per MSTU (3) Annual Dollar Decrease/Increase ((1)x(2)) b. Type of Fuel: **Lie and Labor (1)** Annual Energy Decrease (*)/Increase (-) (2) Cost per MBTU (3) Annual Dollar Decrease/Increase (1)x(2)) (4) Differential Escalation Rate (= \$\frac{1}{2}\frac{1}\frac{1}{2}\frac{1}\frac{1}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac	.05 Y <u>5</u>	- Parting Indete	l Cantan's Correct		
b. Design C. Total C. Total Recurring Benefit/Cost Differential Other Than Energy: a. Annual Labor Decrease (+)/Increase (-) b. Annual Material Decrease (+)/Increase (-) c. Other Annual Decrease (+)/Increase (-) d. Total Costs e. 10t Discount Factor f. Discounted Recurring Cost (d x e) Recurring Energy Benefit/Costs: a. Type of Fuel: (1) Annual Energy Decrease (+)/Increase(-) (2) Cost per MBTU (3) Annual Dollar Decrease/Increase (1)x(2)) (4) Differential Escalation Rate (= \$)Factor (5) Discounted Dollar Decrease/Increase (1)x(2)) (4) Differential Escalation Rate (= TS) Factor (5) Discounted Dollar Decrease/Increase (1)x(2)) (4) Differential Escalation Rate (= TS) Factor (5) Discounted Dollar Decrease/Increase (1)x(2)) (4) Differential Escalation Rate (= TS) Factor (5) Discounted Dollar Decrease/Increase (1)x(2)) (4) Differential Escalation Rate (= TS) Factor (5) Discounted Dollar Decrease/Increase (1)x(2)) (4) Differential Escalation Rate (= TS) Factor (5) Discounted Dollar Decrease/Increase (1)x(2)) (5) Discounted Dollar Decrease/Increase (1)x(2)) (6) Differential Escalation Rate (= TS) Factor (5) Discounted Dollar Decrease/Increase (1)x(2)) (6) Differential Escalation Rate (= TS) Factor (5) Discounted Dollar Decrease/Increase (1)x(2)) (6) Differential Escalation Rate (= TS) Factor (5) Discounted Dollar Decrease/Increase (1)x(2)) (6) Differential Escalation Rate (= TS) Factor (5) Discounted Dollar Decrease/Increase (1)x(2)) (4) Differential Escalation Rate (= TS) Factor (5) Discounted Bollar Decrease/Increase (1)x(2)) (6) Differential Escalation Rate (= TS) Factor (5) Discounted Bollar Decrease/Increase (1)x(2)) (6) Differential Escalation Rate (= TS) Factor (5) Discounted Bollar Decrease/Increase (1)x(2)) (6) Differential Escalation Rate (= TS) Factor (5) Discounted Bollar Decrease/Increase (1)x(2)) (6) Differential Escalation Rate (= TS) Factor (5) Discounted Bollar Decrease/Increase (1)x(2)) (6) Differential Escalation Rate (= TS) Factor (5) Discounted Bollar Decrease/Increase (1)x(2)) (6) Differential Esca			Capital Wats:		\$ 164 A20
C. Total d. Total REFITS Recurring Benefit/Cost Differential Other Than Energy: a. Annual Labor Decrease (+)/Increase (-) b. Annual Material Decrease (+)/Increase (-) c. Other Annual Decrease (+)/Increase (-) d. Total Costs e. 10t Discounte Factor f. Discounted Recurring Cost (d x e) Recurring Energy Benefit/Costs: a. Type of Fuel: (1) Annual Inergy Decrease (+)/Increase (-) (2) Cost per MBTU (3) Annual Dollar Decrease/Increase (1) x(2)) (4) Differential Escalation Rate (= Sfactor (5) Discounted Dollar Decrease/Increase (1) x(2)) (4) Differential Escalation Rate (= TS) Factor (5) Discounted Dollar Decrease/Increase (1) x(2)) (4) Differential Escalation Rate (TS) Factor (5) Discounted Dollar Decrease/Increase (1) x(2)) (4) Differential Escalation Rate (TS) Factor (5) Discounted Dollar Decrease/Increase (1) x(2)) (6) Discounted Dollar Decrease/Increase (1) x(2)) (7) Discounted Dollar Decrease/Increase (1) x(2)) (8) Differential Escalation Rate (TS) Factor (5) Discounted Dollar Decrease/Increase (1) x(2)) (9) Differential Escalation Rate (TS) Factor (5) Discounted Dollar Decrease/Increase (1) x(2)) (1) Annual Inergy Decrease (*)/Increase (*) (2) Cost per MBTU (3) Annual Dollar Decrease/Increase (1) x(2)) (4) Differential Escalation Rate (TS) Factor (5) Discounted Dollar Decrease/Increase (1) x(2)) (4) Differential Escalation Rate (TS) Factor (5) Discounted Dollar Decrease/Increase (1) x(2)) (4) Differential Escalation Rate (TS) Factor (5) Discounted Dollar Decrease/Increase (1) x(2)) (4) Differential Escalation Rate (TS) Factor (5) Discounted Dollar Decrease/Increase (1) x(2)) (6) Discounted Dollar Decrease/Increase (1) x(2)) (7) Annual Inergy Decrease (*)/Increase (*) (8) Annual Inergy Decrease (*)/Increase (*) (8) Annual Inergy Decrease (*)/Increase (*) (9) Annual Inergy Decrease (*)/Increase (*) (1) Annual Inergy Decrease (*)/Increase (*) (2) Cost per MBTU (3) Annual Inergy Decrease/Increase (*) (4) Differential Escalation Rate (TS) (5) Discounted Dollar Decrease	_				
d. Total NREFITS NREFITS Recurring Benefit/Cost Differential Other Than Energy: a. Annual Labor Decrease (+)/Increase (-) b. Annual Material Decrease (+)/Increase (-) c. Other Annual Decrease (+)/Increase (-) d. Total Costs e. 101 Discount Factor f. Discounted Recurring Cost (d x e) Recurring Energy Benefit/Costs: a. Type of Fuel: Energy Decrease (+)/Increase (-) (2) Cost per MSTU (3) Annual Dollar Decrease/Increase (1)x(2)) (4) Differential Escalation Rate (= \$)Factor (5) Discounted Dollar Decrease/Increase (3)x(4) b. Type of Fuel: Elemential Escalation Rate (-) (2) Cost per MBTU (3) Annual Dollar Decrease/Increase (1)x(2)) (4) Differential Escalation Rate (-) (5) Discounted Dollar Decrease/Increase (3)x(4)) (5) Discounted Dollar Decrease/Increase (1)x(2)) (6) Discounted Dollar Decrease/Increase (3)x(4)) (7) Cost per MBTU (8) Annual Energy Decrease (+)/Increase (-) (9) Cost per MBTU (1) Annual Energy Decrease (+)/Increase (-) (2) Cost per MBTU (3) Annual Dollar Decrease/Increase (3)x(4)) (4) Differential Escalation Rate (x) Factor (5) Discounted Dollar Decrease/Increase (3)x(4)) (6) Type of Fuel: (1) Annual Energy Decrease (+)/Increase (-) (2) Cost per MBTU (3) Annual Dollar Decrease/Increase (3)x(4)) (4) Differential Escalation Rate (x) Factor (5) Discounted Dollar Decrease/Increase (3)x(4)) (6) Type of Fuel: (1) Annual Energy Decrease (+)/Increase (-) (2) Cost per MBTU (3) Annual Dollar Decrease/Increase (3)x(4)) (4) Differential Escalation Rate (x) Factor (5) Discounted Dollar Decrease/Increase (1)x(2)) (4) Differential Escalation Rate (x) Factor (5) Discounted Dollar Decrease/Increase (1)x(2)) (6) Discounted Benefits (5un 2f+3e) (7) Discounted Dollar Decrease/Increase (1)x(2) (3) Annual Dollar Decrease/Increase (1)x(2) (4) Differential Escalation Rate (x) Factor (5) Discounted Dollar Decrease/Increase (1)x(2) (6) Discounted Dollar Decrease/Increase (1)x(2) (7) Differential Escalation Rate (x) Factor (5) Discounted Dollar Decrease/Increase (1)x(2) (7) Differential Escalation Rate (x) Factor (5) Discoun		Session of			
REFITS Recurring Benefit/Cost Differential Other Than Energy: a. Annual Labor Decrease (+)/Increase (-) b. Annual Material Decrease (+)/Increase (-) c. Other Annual Decrease (+)/Increase (-) d. Total Costs e. 10t Discount Factor f. Discounted Recurring Cost (d x e) Recurring Energy Benefit/Costs: a. Type of Fuel:					
Recurring Benefit/Cost Differential Other Than Energy: a. Annual Labor Decrease (+)/Increase (-) b. Annual Material Decrease (+)/Increase (-) c. Other Annual Decrease (+)/Increase (-) d. Total Costs e. 101 Discount Factor f. Discounted Recurring Cost (d x e) Recurring Energy Benefit/Costs: a. Type of Fuel:					٠ <u>٠ تو هيکي يا</u> تت نيه
a. Annual Labor Decrease (+)/Increase (-) b. Annual Material Decrease (+)/Increase (-) c. Other Annual Decrease (+)/Increase (-) d. Total Costs e. 10t Discount Factor f. Discounted Recurring Cost (d x e) Recurring Energy Benefit//Costs: a. Type of Fuel:			Differential Other Ti	an France	
b. Annual Material Decrease (*)/Increase (*) c. Other Annual Decrease (*)/Increase (*) d. Total Costs e. 101 Discount Factor f. Discounted Recurring Cost (d x e) Recurring Energy Benefit/Costs: a. Type of Fuel:				ien Energy	1-4 766 IVP
C. Other Annual Decrease (+)/Increase (-) d. Total Costs e. 10: Discount Factor f. Discounted Recurring Cost (d x e) Recurring Energy Benefit/Losts: a. Type of Fuel:	K	Annual Patanial	December (+)/Incomes (-)	. 1	The state of the s
d. Total Costs e. 102 Discount Factor f. Discounted Recurring Cost (d x e) Recurring Energy Benefit/Costs: a. Type of Fuel:				7	
e. 10t Discounted Recurring Cost (d x e) f. Discounted Recurring Cost (d x e) Recurring Energy Benefit/Costs: a. Type of Fuel:			16826 (4)\1\1\1\1\1		
f. Discounted Recurring Cost (d x e) Recurring Energy Benefit/Costs: a. Type of Fuel: Fact Cod (1) (1) Annual Energy Decrease (*)/Increase(-) (2) Cost per MSTU (3) Annual Dollar Decrease/Increase ((1)x(2)) (4) Differential Escalation Rate (= \$)Factor (5) Discounted Dollar Decrease/Increase (3)x(4) b. Type of Fuel: **Line and a code (1)x(2)) (4) Differential Escalation Rate (= 1) Factor (5) Discounted Dollar Decrease/Increase (1)x(2)) (4) Differential Escalation Rate (= 1) Factor (5) Discounted Dollar Decrease/Increase ((3)x(4)) c. Type of Fuel: (1) Annual Energy Decrease (*)/Increase (-) (2) Cost per MBTU (3) Annual Dollar Decrease/Increase ((1)x(2)) (4) Differential Escalation Rate (= 3) Factor (5) Discounted Dollar Decrease/Increase ((3)x(4)) d. Type of Fuel: (1) Annual Dollar Decrease/Increase ((3)x(4)) d. Type of Fuel: (1) Annual Energy Decrease (*)/Increase (-) (2) Cost per MBTU (3) Annual Dollar Decrease/Increase ((3)x(4)) d. Type of Fuel: (1) Annual Energy Decrease (*)/Increase (-) (5) Discounted Dollar Decrease/Increase ((3)x(4)) e. Discounted Energy Benefits (3a(5)+3b(5)+3c(5)+3d(5)) Total Annual Energy Savings (3a(1)+3b(1)+3c(1)+3d(1)) E/C Ratio (Line 6 + Line 1a/1000) Annual Savings (2d+3a(3)+3b(3)+3c(3)+3d(3)) Pay-back Period ((Line 1a - Salvape)+Line B) Annual Savings (2d+3a(3)+3b(3)+3c(3)+3d(3)) Pay-back Period ((Line 1a - Salvape)+Line B)			•		
Recurring Energy Benefit/Costs: a. Type of Fuel:	_				·
a. Type of Fuel:					₹ <u>-50,5</u> 0'1
(1) Annual Energy Decrease (+)/Increase(-) (2) Cost per MSTU (3) Annual Dollar Decrease/Increase (1)x(2)) (4) Differential Escalation Rate (= \$) Factor (5) Discounted Dollar Decrease/Increase (3)x(4) b. Type of Fuel:					
(2) Cost per MSTU (3) Annual Dollar Decrease/Increase ((1)x(2)) (4) Differential Escalation Rate (= \$) Factor (5) Discounted Dollar Decrease/Increase(3)x(4) b. Type of Fuel: **State	•.			-1-1	o MDTΠ
(3) Annual Dollar Decrease/Increase ((1)x(2)) (4) Differential Escalation Rate (= \$) Factor (5) Discounted Dollar Decrease/Increase(3)x(4) (1) Annual Energy Decrease (+)/Increase (-) (2) Cost per MBTU (3) Annual Dollar Decrease/Increase ((1)x(2)) (4) Differential Escalation Rate (= \$) Factor (5) Discounted Dollar Decrease/Increase ((3)x(4)) (5) Discounted Dollar Decrease/Increase ((3)x(4)) (6) Type of Fuel: (1) Annual Energy Decrease (+)/Increase (-) (2) Cost per MBTU (3) Annual Dollar Decrease/Increase ((1)x(2)) (4) Differential Escalation Rate (= \$) Factor (5) Discounted Dollar Decrease/Increase ((3)x(4)) (6) Type of Fuel: (1) Annual Energy Decrease (+)/Increase (-) (2) Cost per MBTU (3) Annual Dollar Decrease/Increase ((3)x(4)) (4) Differential Escalation Rate (= \$) Factor (5) Discounted Dollar Decrease/Increase ((3)x(4)) (4) Differential Escalation Rate (= \$) Factor (5) Discounted Bollar Decrease/Increase ((3)x(4)) (5) Discounted Energy Benefits (3a(5)+3b(5)+3c(5)+3d(5)) (5) Discounted Energy Benefits (3a(5)+3b(5)+3c(5)+3d(5)) (5) Discounted Benefit/Cost Ratio (Line 4+Line 1d) (5) Discounted Benefit/Cost Ratio (Line 4+Line 1d) (6) Total Annual Energy Savings (3a(1)+3b(1)+3c(1)+3d(1)) (7) E/C Ratio (Line 6 + Line 1a/1000) (7) Annual Savings (2d+3a(3)+3b(3)+3c(3)+3d(3)) (8) Pay-back Period ((Line 1a - Salvage)+Line B)) Annual Ener			
(4) Differential Escalation Rate (= \$) Factor (5) Discounted Dollar Decrease/Increase(3)x(4) b. Type of Fuel:				11-/211	T
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Total Benefits (Sun 2f+3e)		(5) Discounted	Dollar Decrease/Increas	e ((3)x(4))	L
Total Benefits (Sum 2f+3e)		Discounted Energ	y Benefits $(3a(5)+3b(5)$	+3c(5)+3d(5))	
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7. E/C Ratio (Line 6 + Line 1a/1000) 9. Annual \$ Savings (2d+3a(3)+3b(3)+3c(3)+3d(3)) 9. Pay-back Period ((Line 1a - Salvage)+).ine B) 124.2 1-1-2 1-3.1 yr	. Tot	al Annual Energy	Savings (3a(1)+3b(1)+3c	(1)+3d(1)}	4.715 MB
). Annual \$ Savings $(2d+3a(3)+3b(3)+3c(3)+3d(3))$). Pay-back Period ((Line 1a - Salvage)+1.ine B) $\frac{19.1}{2}$. E/C	Ratio (Line 6 +	Line 1a/1000)		24,2
). Pay-back Period ((Line la - Salvage)+line B)). Ann	ual \$ Savings (2d	+3a(3)+3b(3)+3c(3)+3d(3))	\$ 10,172
	. Pay	-back Period ((L1	ne la - Salvage) ine B)	
					d - 0

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	on: Colorado		FY = 4
J. s.b	ic Life ar Yrs.		Prepared by TO
OSYS			
	n-recurring Initial	Capital Costs:	• 45
			42
ь.	Salvace		
	Total		<u> 58</u> 842
ENEFI			الله الله الله الله الله الله الله الله
		t Differential Other Th	an Energy:
a.	Annual Labor Decr	ease (+)/Increase (-)	\$ - 1, c 24 /Yr.
	Annual Material D	ecrease (+)/Increase (-) \$ <u>c</u> /Yr.
		ease (+)/Increase (-)	\$c_/Yr.
đ.			1 - 1 024 /Yr.
e.	10: Discount Fact	or	9.524
f.			<u> 7-3</u>
. Re	curring Energy Bene	efit/Costs:	
١.		1-1-011	4 h
	(1) Annual Energ	v Decrease (+)/increase	e(-) <u>e/o</u> Metu S ieura /matu
	(2) Cost per M5	TU	
	(3) Annual Dolla	r Decrease/Increase (()	(x(2))
		Escalation Rate (@ 1	
	- •	Dollar Decrease/Increase	(3)x(4) \$_1 ! C: C = T
۵.	Type of Fuel:	y Decrease (+)/Increase	(-) ie MBTU_
	(2) Cost per MB		\$ SECT /MBTU
	(3) Annual Dolla	r Decrease/Increase (()	~
	(4) Differentia	Escalation Rate (7_1	Factor 12,540
	(5) Discounted I	pollar Decrease/Increase	((3)x(4)) \$ 997.
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_	(1) Annual Energ	y Decrease (+)/Increase	(-) MBTU_
	(2) Cost per MB	TU	\$MBTU_
	(3) Annual Dolla	ar Decrease/Increase (('	1)x(2)) \$
	(4) Differentia	l Escalation Rate (%)	Factor
		Dollar Decrease/Increase	2 ((3)x(4)) \$
đ.			P / 1
	(1) Annual Ener	gy Decrease (+)/Increase	(-) MBTU
	(2) Cost per MB	TU	1)x(2))
	(3) Annual Doll	er Decrease/Increase ((
	(4) Differentia	1 Escalation Rate (_\$)	1/2\-/4\\
	(5) Discounted	Dollar Decrease/Increase	+3c(5)+3d(5)) 191 632
. <u>.</u>	Discounted Energ	y Benefits $(3a(5)+3b(5$	*35(5)*30(5)) *181.879
. To	tal Benefits (Sum	eivjej nut Batta – (i taa dal taa	
. D1	iscounted Benefit/U	ost Ratio (Line 4+Line Savings (3a(1)+3b(1)+3c	
	/C Ratio (Line 6 + 1	1100 1a/1000)	/ 17.00(1)
), E/), Ar	nous & Caving C 124	+3a(3)+3b(3)+3c(3)+3d(3	· ·
). Pi	w-back Period (114	ne la - Salvage) Line B) <u>55</u> 3 yr
	•		0 - 12 F 537
o. Li	fer cycle cost (Line 1d-21-30)	0 - 10 E + 5 E - 1

Project: Air France Academy	FY =4
Economic Life: 25 Yrs. Date Prepared 9/2/ Prepared by	TUP
TOSYS 1. hon-recurring Initial Capital Costs:	
a. CNE b. Design c. <u>Partuage</u>	15 7 7 7 13 5 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
d. TotalBENEFITS:2. Recurring Benefit/Cost Differential Other Than Energy:	17 065
 a. Annual Labor Decrease (+)/Increase (-) b. Annual Material Decrease (+)/Increase (-) 	- 36 - /Yr. C /Yr. C /Yr.
d. Total Costs e. 10% Discount Factor	-865 /Yr.
 f. Discounted Recurring Cost (d x e) 3. Recurring Energy Benefit/Costs: a. Type of Fuel: Processing 	2 42 ³
 (1) Annual Energy Decrease (+)/Increase(-) (2) Cost per M5TU (3) Annual Dollar Decrease/Increase ((1)x(2)) 	276 MBTU 2 ya /MBTU 2 gaz /Yr.
 (4) Differential Escalation Rate (= 3) Factor (5) Discounted Dollar Decrease/Increase(3)x(4) b. Type of Fuel: 	

catio	n: Celaracie	2001025 00		N = 4
6	c Life: 25 Yrs.	Date Prepared 10/61	Prepared by_	TUB
15 T 5				
	-recurring Initia	l Capital Costs:		
8.	CME	,		\$ 1 FT 17 636
ь.	Des 1 gn			\$ 107 919
Ç.	-22 1000c			\$
d.	Total			<u> </u>
NEFIT		D///	- F	,
Rec	urring benefit/co.	st Differential Other Tha reise (+)/Increase (-)	n Energy:	\$ - = 2 2 34 /Yr.
b.	Annual Material	Decrease (+)/Increase (-)		-52 / 52. / Yr.
c.		rease (+)/Increase (-)		<u> </u>
-	Total Costs	case (1)/incicase ()		-22:24 /Yr.
	10: Discount Fact	tor		2 524
f.		ring Cost (d x e)		-316.52
Rec	urring Energy Beni			`
₿.	Type of Fuel: 😑	ual oil		
		<pre>Qv Decrease (+)/Increase(</pre>	-)	<u> 22 //동</u> MBTU
	(2) Cost per M5		4011	12 TE METU
		or Decrease/Increase ((1)		\$ 204 745/Yr.
		1 Escalation Rate (5 %)		20.050
۵.		Dollar Decrease/Increase(3)X(4)	<u> = 112 = 1</u>
D.	Type of Fuel: ∈	cy Decrease (+)/Increase	(-)	CA9 METU
	(2) Cost per MB		(-)	\$ = 7 /MBTU
		er Decrease/Increase ((1)	1(2))	\$ 1296 /11.
		1 Escalation Rate (7 %)		18.349
		Dollar Decrease/Increase		35 961
C.	Type of Fuel:			
		gy Decreese (+)/Increase	(-)	MBTU
	(2) Cost per MB		4-11	\$ /MBTU
		ar Decrease/Increase ((1)		\$ <u>/Yr.</u>
		l Escalation Rate (%) F		
4		Dollar Decrease/Increase	((3)x(4))	\$
₫.	Type of Fuel: (1) Annual Ener	A CONTRACTOR OF THE CONTRACTOR	(-)	PETU_
	(2) Cost per MB	gy Decrease (+)/Increas:	(-)	\$ 7M8TU
	(3) Annual Doll.	or Decrease/Increase ((1)	-1211	The state of the s
	(4) Differentia	1 Escalation Rate (_X)Fa	ctor	\$ <u>/Yr.</u>
		Dollar Decrease/Increase		\$
•.	Discounted French	y Benefits (34(5)+3b(5)+3	c(5)+3d(5))	6 146, CC
	al Benefits (Simi	21+3e)	-,0,00000	<u> </u>
		ost Ratio (Line 4+Line 1	d)	_ <u>=_274</u>
Tot	al Annual Energy :	Savings (3a(1)+3b(1)+3c(1		22.764 Mit
E/C	Ratio (Line 6 +)	Line 1a/1000)	•	15.0
Ann	ual \$ Savings (2d-	+34(3)+36(3)+3c(3)+3d(3))	1	\$ <u>275.5</u> 03
Pay	-back Period ((Li	ne la - Salvage)+Line 8)		<u> 55</u> 7
Lif	e-chole cont	(Line 1d - 21 - 20)		-44,112,99

FORTH A-I

Location: Alexander Company		<u>n =4</u>
Project: Value band Heal		
Economic Life: 2:- Yrs. Date F	repared 1/00 Prepared by	- 2
	Tepared by	
COSTS		
1. hon-recurring Initial Capital	Costs:	
a. CHE		\$ <u>- 12 - 317 </u>
b. Design		777 743
d. Total		
d. Total BENEFITS		1, 1 <u>2, 7, 76, 66, 66, 66, 66, 66, 66, 66, 66,</u>
2. Recurring Benefit/Cost Differe	intial Other Than Energy:	
a. Annual Labor Decrease (+)	Increase (-)	\$ -27_Ent /Yr.
b. Annual Material Decrease (+)/Increase (-)	1 / YF.
c. Other Annual Decrease (+)/	Increase (+)	\$ TYP.
d. Total Costs	, ,	\$ -37.502 /Yr.
e. 101 Discount Factor		9 5 2.4
f. Discounted Recurring Cost	(d x e)	-257 171
3. Recurring Energy Benefit/Costs	;	
a. Type of Fuel: Transcript Oction (1) Annual Energy Decrease	(a /a)/(acmasa/a)	es per MBTU
(2) Cost per MSTU	se (+)/Increase(-)	\$ /2 7 = /MaTU
(3) Annual Dollar Decreas	e/Increase ((1)x(2))	\$ 5:4 745/Yr.
(4) Differential Escalati	on Rate (= \$)Factor	27.1500
(5) Discounted Dollar De:	rease/Increase(3)x(4)	115 121
b. Type of fuel: Electrici		
(1) Annual Energy Decreas	se (+)/Increase (-)	FRAC MBTU
(2) Cost per MBTU		3 CT MBTU
(3) Annual Dollar Decreas (4) Differential Escalati		\$ 12 AFF TYP.
	on Rate (7 %) Factor (rease/Increase ((3)x(4))	18,749
C. Type of Fuel:		
(1) Annual Energy Decreas	e (+)/Increase (-)	_ MBTU
(2) Cost per MBTU	•	/MBTU
. (3) Annual Dollar Decrea:		\$ /Yr.
	Ion Rate (_S) Factor	
(5) Discounted Dollar De	rease/Increase ((3)x(4))	
d. Type of Fuel:	(1)	MAT.
 Annual Energy Decrea. Cost per MBTU 	se (+)/Increase (-)	S /HBTU
(3) Annual Dollar Decrea:	se/Increase ((1)x(2))	\$
(4) Differential Escalat	ion Rate (%)Factor	
	rease/increase ((3)x(4))	5
e. Discounted Energy Benefit:		6.40% (31
4. Total Benefits (Sun 2f+3e)		6 044 460
5. Discounted Benefit/Cost Ratio	(Line 4+Line ld)	3, 12.5
6. Total Annual Energy Savings ([a(1)+3b(1)+3c(1)+3d(1)]	77 475 WELL
7. E/C Ratio (Line 6 + Line 1a/1)	000)	16.C4.3
0. Annual & Savings (2d+3a(?)+3b) 9. Pay-back Period ((Line la - Sa	3]43C(3]43D(3]]	263 618
or relient terion (fills is a 20	ITANETAPINE DI	6.037 y.
10. Life-Cycle Cont (Line	ナリー ロー コピー	-3 4, 112, 714

Froject: Vandenberg Half 6.7 E and 2 Economic Life: 25 Yrs. Date Prepared 9/50 Prepared by FLP COSTS 1. Non-recurring Initial Capital Costs: a. CNS b. Design c. Galuage d. Total BENEFITS 2. Recurring Benefit/Cost Differential Other Than Energy:
Economic Life: 25 Yrs. Date Prepared 9/50 Prepared by FID COSTS 1. Non-recurring Initial Capital Costs: a. CNI b. Design c. Salvage d. Total BENEFITS 2. Recurring Benefit/Cost Differential Other Than Energy:
T. Non-recurring Initial Capital Costs: a. CNS b. Design c. Salvage d. Total BENEFITS 2. Recurring Benefit/Cost Differential Other Than Energy:
T. Non-recurring Initial Capital Costs: a. CNS b. Design c. Salvage d. Total BENEFITS 2. Recurring Benefit/Cost Differential Other Than Energy:
b. Design c. Salvage d. Total BENEFITS 2. Recurring Benefit/Cost Differential Other Than Energy:
d. Total BENEFITS 2. Recurring Benefit/Cost Differential Other Than Energy:
d. Total BENEFITS: 2. Recurring Benefit/Cost Differential Other Than Energy:
BENEFITS 2. Recurring Benefit/Cost Differential Other Than Energy:
A A 1 1 - 1 - A 1 - 1 - 1
a. Annual Labor Decrease (+)/Increase (-) \$-27.730/Yr.
b. Annual Material Decrease (+)/Increase (-) c. Other Annual Decrease (+)/Increase (-) \$ 0 /Yr. \$ 7/7.
d. Total Costs \$-37.730/Yr.
e. 10% Discount Factor
f. Discounted Recurring Cost (d x e) \$_354,236
3. Recurring Energy Benefit/Costs:
a. Type of Fuel: E. () (1) Annual Energy Decrease (+)/Increase(-)
(2) Cost per Matu S_13.7= /Matu
(3) Annual Dollar Decrease/Increase ((1)x(2)) \$ 3c4 6c7/Yr.
(4) Differential Escalation Rate (PS) Factor
(5) Discounted Dollar Decrease/Increase(3)x(4) \$ 6,167,276
(1) Annual Energy Decrease (+)/increase (-) 5.72c MBTU
(2) Cost per MaTU S 3.07 /MBTU
(3) Annual Dollar Decrease/Increase ((1)X(2)) \$ 17.565 /Yr.
(4) Differential Escalation Rate (7 8) Factor
(5) Discounted Dollar Decrease/Increase ((3)x(4)) \$ = 16 = 150
(1) Annual Energy Decrease (+)/Increase (-) MBTU
(2) Cost per MBTU \$
(3) Annual Dollar Decrease/Increase ((1)x(2)) \$ /Yr.
(4) Differential Escalation Rate (_8) Factor (5) Discounted Pollar Decrease/Increase ((3)x(4)) 8
d. Type of Fuel:
(1) Annual Energy Decrease (+)/Increase (-) MBTU
(2) Cost per MBTU
(3) Annual Dollar Decrease/Increase ((1)x(2)) \$ //r.
(4) Differential Escalation Rate (S)Factor (5) Discounted Dollar Decrease/Increase ((3)x(4))
e. Discounted Energy Benefits (3a(5)+3b(5)+3c(5)+3d(5))
4. Total Benefits (Sum 2f+Je)
5. Discounted Benefit/Cost Ratio (Line 4-Line 1d)
6. Total Annual Energy Savings (3a(1)+3b(1)+3c(1)+3d(1)) 7. E/C Ratio (Line 6 + Line 1a/1000)
7. E/C Ratio (Line 6 + Line la/1000) 8. Annual & Savings (2d+3a(3)+3b(3)+3c(3)+3d(3)) 3.244,437
9. Pay-back Period (Line la - Salvage) Line B)
= Life-Cycle Cost (Line 1d-21 2e) -\$ 4,17,254

Project: Air Force Account A 7 B 2 and 3 Economic Life: Trs. Date Prepared 9/62 Prepared by	
TOSTS 1. hon-recurring Initial Capital Costs: a. CNE b. Design c. Extension	2.02A A 5 1 242 GM L
d. TotalBENEFITS2. Recurring Benefit/Cost Differential Other Than Energy:	£ 124, 522
 Recurring Benefit/Cost Differential Other Than Energy: Annual Labor Decrease (+)/Increase (-) Annual Material Decrease (+)/Increase (-) Other Annual Decrease (+)/Increase (-) Total Costs 10% Discount Factor Discounted Recurring Cost (d x e) Recurring Energy Benefit/Costs: Type of Fuel: Type of Fuel: 	-41.021 /Yr. -41.021 /Yr. -41.021 /Yr. -4.524
(1) Annual Energy Decrease (*)/Increase(*) (2) Cost per M5TU (3) Annual Dollar Decrease/Increase ((1)x(2)) (4) Differential Escalation Rate (= \$)Factor (5) Discounted Dollar Decrease/Increase(3)x(4) b. Type of Fuel: enterglanding	FIRE CAC METU FIRE CACACACACACACACACACACACACACACACACACACA
(1) Annual Energy Decrease (+)/Increase (-) (2) Cost per MBTU (3) Annual Dollar Decrease/Increase ((1)x(2)) (4) Differential Escalation Rate (7 %) Factor (5) Discounted Dollar Decrease/Increase ((3)x(4)) 5. Type of Fuel:	2 2 7 MBTU 12 27 MBTU 12 27
(1) Annual Energy Decrease (+)/Increase (-) (2) Cost per MBTU (3) Annual Dollar Decrease/Increase ((1)x(2)) (4) Differential Escalation Rate (_\$) Factor (5) Discounted Dollar Decrease/Increase ((3)x(4)) d. Type of Fuel:	MBTU /MBTU /Yr,
 Annual Energy Decrease (+)/Increase (-) Cost per MBTU Annual Dollar Decrease/Increase ((1)x(2)) Differential Escalation Rate (_S)Factor Discounted Dollar Decrease/Increase ((3)x(4)) 	MBTU /MBTU /Yr.
 e. Discounted Energy Benefits (3a(5)+3b(5)+3c(5)+3d(5)) 4. Total Benefits (Sum 2f+3e) 5. Discounted Benefit/Cost Ratio (Line 4+Line 1d) 6. Total Annual Energy Savings (3a(1)+3b(1)+3c(1)+3d(1)) 7. E/C Ratio (Line 6 + Line 1a/1000) 8. Annual \$ Savings (2d+3a(3)+3b(3)+3c(3)+3d(3)) 9. Pay-back Period ((Line 1a - Salvage)+Line B) 	6,46,287 6,41,031 2,451 30,720 NB u 15,4 301,433 6,42 yr
10) hite - suche as a such state en a such	3-4,262,649

		- 11 20 - 20 - 1 - 1 - 1 - 1 - 1 - 1 - 1 - 1 - 1 -		N Sa
Project: Val	podic lich	Hall Lucater Eurol	- 40.00	note College
Economic Life:	Yrs. D	ate Prepared 7/A:	2 Prepared by	J. P.
COSTS				
1. hon-recurri a. CKE	ng Initial Cap	oftal Costs;		\$ 544 123
b. Design				44 059
المفار	الدورا و			2
d. Total BENEFITS				290,192
	enefit/Cost Di	fferential Other T.	han Energy:	
a. Annual	Labor Decrease	(+)/Increase (-)		\$ -7,600 /Yr.
		ase (+)/Increase (-)	e /yr.
c. Other A d. Total C	nnual Decrease Osts	(+)/Increase (-)		\$ -7. 477 /Yr.
	count Factor			52.4
	ted Recurring			\$ <u>-7:116</u>
	nergy Benefit/ Fuel <u>: =</u>			
		crease (+)/increas	e(-)	5,459 mi tu
(2) Co	st per MSTU		•	12.72 /MSTU
		crease/Increase ((alation Rate (<		75 225 /Yr.
\ / \ •	scounted Dolla	r Decrease/Increas	e(3)x(4)	\$ 1.505_2.61_
b. Type of	fuel: Elec-	tricitus.		
(1) An (2) Co	inual Energy De ist per MBTU	crease (+)/Increas	e (-)	- 2.9 7 MBTU \$ 21.57 /HBTU
		crease/Increase ((1)x(2))	\$ -9 /2 /Yr.
(4) D1	fferential Esc	alation Rate (7	1) factor	16. 4.0
(5) D1	scounted Dolla	r Decrease/Increas	e ((3)x(4))	-16 4 21
C. Type of	nual Energy De	crease (+)/Increas	- (-)	MBTU_
(?) Ca	ist per MBTU	-	- 	\$ /MBTU
		crease/increase ((\$Yr.
		calation Rate (%) or Decrease/Increas		· ·
d. Type of			-	V
		crease (+)/increas	ā (-)	MBTU
(2) Co	st per MBTU	crease/Increase ((11-/211	MBTU
(3) An	fferential Esc	alation Rate (_\$)	Factor	
(5) D1	scounted Dolla	r Decrease/Increas	e ((3)x(4))	
e. Discoun	ted fnorgy Ber	efits (30(5)+3b(5)	+3c(5)+3d(5))	1 491,800
	its (Sum 21+3e	:) Latio (Line 4+Line	141	3.62
		ngs (3a(1)+Jb(1)+3c		- 162 AIBI
7. E/C Ratio (Line 6 + Line	14/1000)		15.0
)}+3b(3)+3c(3)+3d(3 - Salvage)+Line		5.16
•		<u>-</u>		-\$ 1.02F.442
10 . Lite - Cy	פוב כיחבית ע	m //e 19 - 5-1 - 5-6	• •	+ -+

Location: Colorado Tarrios CE	N =4
Project: Field House	
Economic Life: 25 Yrs. Date Prepared 9/6: Prepared by	
Economic Life: 25 Yrs. Date Prepared 9/6: Prepared by	
COSYS	
T. hon-recurring Initial Capital Costs:	A
a. CME	70 = FW"
b. Design c. ————————————————————————————————————	42 347
d. Total	795 214
BENEFITS	
Recurring Benefit/Cost Differential Other Than Energy:	
a. Annual Labor Decrease (+)/Increase (-)	\$ -15, 3-11 /Yr.
b. Annual Material Decrease (+)/Increase (-)	O /Yr.
c. Other Annual Decrease (+)/Increase (-)d. Total Costs	-15 391 /Yr.
e. 101 Discount Factor	1,524
f. Discounted Recurring Cost (d x e)	\$ - 146 584
3. Recurring Energy Benefit/Costs:	·——·
a. Type of Fuel: Evel Col	4
(1) Annual Energy Decrease (+)/Increase(-)	10 542 PETU
(2) Cost per M5TU (3) Annual Dollar Decrease/Increase ((1)x(2))	45 25-/Yr.
(4) Differential Escalation Rate (= \$) Factor	20:50
(5) Discounted Dollar Decrease/Increase(3)x(4)	\$ 2.912 424
b. Type of Fuel: Electricity	- AMP 11
(1) Annual Energy Decrease (+)/Increase (-)	S = 27 /MBTU
(2) Cost per MBTU (3) Annual Dollar Decrease/Increase ((1)X(2))	S / /MBIU
(3) Annual Dollar Decrease/Increase ((1)X(2)) (4) Differential Escalation Rate (¬ S) Factor	10 4-1
(5) Discounted Dollar Decrease/Increase ((3)x(4))	\$
c. Type of Fuel:	
. (1) Annual Energy Decrease (+)/Increase (-)	MBTU
(2) Cost per MBTU	/MBYU
(3) Annual Dollar Decrease/Increase ((1)x(2)) (4) Differential Escalation Rate (_3) Factor	
(5) Discounted Dollar Decrease/Increase ((3)x(4))	3
d. Type of Fuel:	
(1) Annual Energy Decrease (+)/Increase (-)	MBTU
(2) Cost per MBTU	/KBTU
(3) Minual Dollar Detrease/Increase ((1/A(6//	
(4) Differential Escalation Rate (%)Factor (5) Discounted Dollar Decrease/Increase ((3)x(4))	
e. Discounted Energy Benefits (3a(5)+3b(5)+3c(5)+3d(5))	2 912, 924
4. Total Benefits (Sum 2f+3e)	2, 766, 340
5. Discounted Benefit/Cost Ratio (Line 4+Line 1d)	3,479
6. Total Annual Energy Savings (3a(1)+3b(1)+3c(1)+3d(1))	10,143
7. E/C Ratio (Line 6 + Line la/1000)	\$ <u>129.0</u> 42
8. Annual & Savings (2d+3a(3)+3b(3)+3c(3)+3d(3)) 9. Pay-back Period ((Line la - Salvape)+Line 8)	5.41
	- 4 1 971, 126
is life-cycle Court (Line 1d-2f-3e)	-

FORT A-1

Location: Calando Epringo Co	N 54
Reduce There potest Setting Prepared by Conomic Life: 775. Date Prepared 9/62 Prepared by	
TOSYS 1. hon-recurring Initial Capital Costs:	
a. CME b. Design	16 4 6 "
c. Salvage	
d. Total BENEFITS	<u> </u>
Recurring Benefit/Cost Differential Other Than Energy:	\$ -6.934/Yr.
 a. Annual Labor Decrease (+)/Increase (-) b. Annual Material Decrease (+)/Increase (-) 	3 <u>0 /Yr.</u>
c. Other Annual Decrease (+)/Increase (-)d. Total Costs	0 /1r. -6 934 /1r.
e. 10: Discount Factor	7,980
f. Discounted Recurring Cost (d x e)3. Recurring Energy Benefit/Costs:	<u>- 115</u> 375
a. Type of Fuel: Fuel Oil	≥ 7/80 METU
(1) Annual Energ. Decrease (+)/Increase(-) (2) Cost per MSIU	\$ /R TE /Katu
 (3) Annual Dollar Decrease/Increase ((1)x(2)) (4) Differential Escalation Rate (£ 5)Factor 	\$ 50.055/Yr.
(5) Discounted Dollar Decrease/Increase(3)x(4)	65% 475
b. Type of Fuel: = - c-level (+)/Increase (-)	996 MBTU
(2) Cost per MBTU	S - c - /MBTU S - c - x - x - x - x - x - x - x - x - x
 (3) Annual Dollar Decrease/Increase ((1)X(2)) (4) Differential Escalation Rate (7 %) factor 	12 - 7 -
<pre>(5) Discounted Dollar Decrease/Increase ((3)x(4)) c. Type of Fuel:</pre>	2.5.5%
(1) Annual Energy Decrease (+)/Increase (-)	S MBTU MBTU
(2) Cost per MBTU (3) Annual Dollar Decrease/Increase ((1)x(2))	1 / YF.
(4) Differential Escalation Rate (_\$) Factor	
d. Type of Fuel:	
(1) Annual Energy Decrease (+)/Increase (-) (2) Cost per MBTU	S MBTU MATU
(3) Annual Dollar Decrease/Increase ((1)x(2))	\$/Yr
 (4) Differential Escalation Rate (%) Factor (5) Discounted Dollar Decrease/Increase ((3)x(4)) 	
 Discounted Energy Benefits (3a(5)+3b(5)+3c(5)+3d(5)) 	119 542
4. Total Benefits (Sun 2f+Je) 5. Discounted Benefit/Cost Ratio (Line 4+Line 1d)	1.254
 Total Annual Energy Savings (3a(1)+3b(1)+3c(1)+3d(1)) E/C Ratio (Line 6 + Line 1a/1000) 	4.15°
8. Annual \$ Savings (2d+3a(3)+3b(3)+3c(3)+3d(3))	\$ 40.132
9. Pay-back Period ((Line is - Salvage)+Line 8)	4-305,936
10. Lite- Cycle Cost (Line 1d-2f-2e)	

FORTH A-I

Project: Field Herra	<u> </u>	TY 54
Economic Life: 25 Vrs. De	te Prepared N/s = Prepare	od by
COSTS 1. Non-recurring Initial Capi a. CNE b. Design c	Ital Costs:	115 com 15 x 15 0 13 1 0 15
2. Recurring Benefit/Cost Dif a. Annual Labor Decrease b. Annual Material Decrea c. Other Annual Decrease d. Total Costs e. 10% Discount Factor f. Discounted Recurring C 3. Fecurring Energy Benefit/C	(+)/Increase (-) ase (+)/Increase (-) (+)/Increase (-) Cost (d x e) Costs:	y: -2.536 /Yr. -2.536 /Yr. -2.536 /Yr. -3.524 /Yr. -2.536 /Yr.
(2) Cost per MSTU (3) Annual Dollar De: (4) Differential Esci (5) Discounted Dollar b. Type of Fuel: (1) Annual Energy Dei (2) Cost per MBTU	crease (+)/Increase(-) crease/Increase ((1)x(2)) alation Rate (= \$)Factor r Decrease/Increase(3)x(4) crease (+)/Increase (-)	1 = .7 = MBTU 2 = / MBTU 2 = / MBTU 2 = / MBTU
(4) Differential Esci (5) Discounted Dollar C. Type of Fuel: (1) Annual Energy De (2) Cost per MBTU (3) Annual Dollar De (4) Differential Esc (5) Discounted Dolla	crease/Increase ((1)X(2)) alation Rate (7 1) Factor r Decrease/Increase ((3)x(4) crease (+)/Increase (-) crease/Increase ((1)x(2)) alation Rate (1) Factor r Decrease/Increase ((3)x(4))) \$
(2) Cost per MBTU (3) Annual Dollar De (4) Differential Esc (5) Discounted Dolla e. Discounted Energy Ben 4. Total Benefits (Sum 2f+3e	crease (+)/increase (-) crease/increase ((1)x(2)) alation Rate (_%)Factor r Decrease/increase ((3)x(4) efits (3a(5)+3b(5)+3c(5)+3d	(5)) 423 250 398 01
5. Discounted Benefit/Cost R 6. Total Annual Energy Savin 7. E/C Ratio (Line 6 + Line 8. Annual & Savings (2d+3a(3) 9. Pay-back Period ((Line la	utio (Line 4+Line 1d) .gs (3a(1)+3b(1)+3c(1)+3d(1) 1a/1000) .)+3b(3)+3c(3)+3d(3)) Salvage)+Line 8)	5,039 1,739 15.0 15.0 15.0 4-267,086

Location: Onlawade Spring Co	PY E4
Project: Field House	
Economic Life: 2 - Yrs. Date Prepared @ / FT Prepared by	7/2
COSTS	
T. hon-recurring Initial Capital Costs:	
e. CNE	990,2
b. Design c. Salucice	116 4 61
d. Total	1 327 161
BENEFITS	,
Recurring Benefit/Cost Differential Other Than Energy:	A 40 584m
 a. Annual Labor Decrease (+)/Increase (-) b. Annual Material Decrease (+)/Increase (-) 	= 19 49 = 14r. = - 14r.
c. Other Annual Decrease (+)/Increase (-)	0 /Yr.
d. Total Costs	\$ -1 > 40: /Yr.
e. 10: Discount Factor	4 524
f. Discounted Recurring Cost (d x e)	<u>-786</u> 455
3. Recurring Energy Benefit/Costs: a. Type of Fuel: Fig. 1 0 1	
(1) Annual Energ. Decrease (+)/Increase(-)	/2 7 <u>54</u> M ETU_
(2) Cost per MSTU	\$ 1= 75 MBTU
(3) Annual Dollar Decrease/Increase ((1)x(2))	\$ 176 166/Yr.
(4) Differential Escalation Rate (⊆ S)Factor (5) Discounted Dollar Decrease/Increase(3)x(4)	2.0 0F C
b. Type of Fuel: Electricity	
(1) Annual Energy Decrease (+)/Increase (-)	569 MBTU
(2) Cost per MBTU	# / /MBTU
(3) Annual Dollar Decrease/Increase ((1)X(2)) (4) Differential Escalation Rate (10 (44)
(5) Discounted Dollar Decrease/Increase ((3)x(4))	\$ <u></u>
c. Type of Fuel:	
. (1) Annual Energy Decrease (+)/Increase (-)	MBIU
(2) Cost per MBTU	MBTU
 (3) Annual Dollar Decrease/Increase ((1)x(2)) (4) Differential Escalation Rate (\$) Factor 	\$YF.
(5) Discounted Dollar Decrease/Increase ((3)x(4))	\$
d. Type of Fuel:	
(1) Annual Energy Decrease (+)/Increase (+)	MBTU
(2) Cost per MBTU	/HBTU
 (3) Annual Dollar Decrease/Increase ((1)x(2)) (4) Differential Escalation Rate (_S)Factor 	\$ <u>/\rac{\rac{\rac{\rac{\rac{\rac{\rac{</u>
(5) Discounted Dollar Decrease/Increase ((3)x(4))	
 Discounted Energy Benefits (3a(5)+3b(5)+3c(5)+3d(5)) 	3.563, 520
4. Total Benefits (Sum 27+Je)	3 377, 965
5. Discounted Benefit/Cost Ratio (Line 4-Line 1d)	3 354
 Total Annual Energy Savings (3a(1)+3b(1)+3c(1)+3d(1)) E/C Ratio (Line 6 + Line 1a/1000) 	15.C
8. Annual & Savings (2d+3a(3)+3b(3)+3c(3)+3d(3))	\$ 158 418
 Pay-beck Period ((Line la - Salvage) (Line 8) 	E. 62
10. Life-Cycle Cost (Line 11 - 2f - Be)	1-2,370, BCA

Project: Eight House	N 64
Economic Life: 25 Yrs. Date Prepared Q /A2 Prepared by	TE
TOOTS T. hon-recurring Initial Capital Costs: a. CME b. Design c. Sollewise d. Total BENEFITS:	99126
 Recurring Benefit/Cost Differential Other Than Energy: Annual Labor Decrease (+)/Increase (-) Annual Material Decrease (+)/Increase (-) Other Annual Decrease (+)/Increase (-) Total Costs 101 Discount Factor Discounted Recurring Cost (d x e) Recurring Energy Benefit/Costs: 	-21,707/Yr21,707/Yr21,707/Yr224
(1) Annual Energy Decrease (+)/Increase(-) (2) Cost per MSTU (3) Annual Dollar Decrease/Increase ((1)x(2)) (4) Differential Escalation Rate (= %)factor (5) Discounted Dollar Decrease/Increase(3)x(4) b. Type of Fuel: The Annual Liberty Decrease (+)/Increase (-) (1) Annual Energy Decrease (+)/Increase (-) (2) Cost per MSTU (3) Annual Dollar Decrease/Increase ((1)x(2))	74 250 PSTU 72 72 /MSTU 133 609 /YF. 26 85 0 26 81 860 219 HBTU 2 72 /MSTU 2 514 /YF.
(4) Differential Escalation Rate (7 %) Factor (5) Discounted Dollar Decrease/Increase ((3)x(4)) C. Type of Fuel: (1) Annual Energy Decrease (+)/Increase (-) (2) Cost per MBTU (3) Annual Dollar Decrease/Increase ((1)x(2)) (4) Differential Escalation Rate (%) Factor (5) Discounted Dollar Decrease/Increase ((3)x(4)) d. Type of Fuel:	MBTU MBTU MBTU MBTU MBTU
(1) Annual Energy Decrease (+)/Increase (-) (2) Cost per MBTU (3) Annual Dollar Decrease/Increase ((1)x(2)) (4) Differential Escalation Rate (%)Factor (5) Discounted Dollar Decrease/Increase ((3)x(4)) (6) Discounted Energy Benefits (3a(5)+3b(5)+3c(5)+3d(5)) (7) Total Benefits (5um 2f+3e) (8) Discounted Benefit/Cost Ratio (Line 4+Line 1d) (9) Total Annual Energy Savings (3a(1)+3b(1)+3c(1)+3d(1)) (1) Total Annual Energy Savings (3a(1)+3b(1)+3c(1)+3d(1)) (1) Total Annual Energy Savings (3a(1)+3b(1)+3c(1)+3d(1))	MBTU /MBTU /YF. 3,427,235
Annual & Savings (20+3a(3)+3b(3)+3c(3)+3d(3)) B. Pay-back Period ((Line la - Salvage)+Line B) 10. Life - Cycle Cest (Line Ld 24-3a)	174 416 5,68 11 - 2,578,992

Project: Field House	N EZ
Economic Life: 25 Yrs. Date Prepared 9/82 Prepared by	200 115
COSTS	
T. Aon-recurring Initial Capital Costs:	• . •
e. CNI b. Design	2,374
e. Salvane	2
d. Total	20,441
BENEFITS	· · · · · · · · · · · · · · · · · · ·
2. Recurring Benefit/Cost Differential Other Than Energy:	1 201 IV-
 a. Annual Labor Decrease (+)/Increase (-) b. Annual Material Decrease (+)/Increase (-) 	- 396 /Yr.
C. Other Annual Decrease (+)/Increase (-)	\$/Yr.
d. Total Costs	8 - 346 /Yr.
e. 101 Discount Factor	0.574
f. Discounted Recurring Cost (d x e)3. Recurring Energy Benefit/Costs:	3-3-772
a. Type of Fuel: Fuel Oil	
(1) Annual Energy Decrease (+)/Increase(-)	_57/_ MBTU_
(2) Cost per MSTU	\$ = 7 = /MSTU
(3) Annual Dollar Decrease/Increase ((1)x(2))	\$ 7,965/Yr.
(4) Differential Escalation Rate (5,8)Factor (5) Discounted Dollar Decrease/Increase(3)x(4)	\$ 157.753
b. Type of Fuel: Elect-icity	
(1) Annual Energy Decrease (+)/Increase (-)	-Ban MBTU
(2) Cost per MBTU	S /KETU
(3) Annual Dollar Decrease/Increase ((1)X(2))	8 - 421 /Yr.
 (4) Differential Escalation Rate () Factor (5) Discounted Dollar Decrease/Increase ((3)x(4)) 	2, (40)
c. Type of fuel:	- 16 623
· (1) Annual Energy Decrease (+)/Increase (-)	MBTU_
(2) Cost per MBTU	MBTU
. (3) Annual Dollar Decrease/Increase ((1)x(2))	\$/Yr.
 (4) Differential Escalation Rate (18) Factor (5) Discounted Dollar Decrease/Increase ((3)x(4)) 	6
d. Type of Fuel:	-
(1) Annual Energy Decrease (+)/Increase (-)	MBTU
(2) Cost per MBTU	\$ /MAYU
(3) Annual Dollar Decrease/Increase ((1)x(2))	ł /r.
 (4) Differential Escalation Rate (_%)Factor (5) Discounted Dollar Decrease/Increase ((3)x(4)) 	
 (5) Discounted Dollar Decrease/Increase ((3)x(4)) e. Discounted Energy Renefits (3a(5)+3b(5)+3c(5)+3d(5)) 	141.130
4. Total Benefits (Sum 2f+3e)	137.359
5. Discounted Benefit/Cost Ratio (Line 4.Line 1d)	6 120
 Total Annual Energy Savings (3a(1)+3b(1)+3c(1)+3d(1)) 	271
7. E/C Ratio (Line 6 + Line la/1000)	ر ميکري
<pre>0. Annu_1 \$ Savings (2d+3a(3)+3b(3)+3c(3)+3d(3)) 0. Pay-back Period ((Line la ~ Salvage)+Line 8)</pre>	2,76
	116 017
o, Lite-Cycle Co. + (Line 1d- 47- 50)	\$ - 116, 411

Location: Contracto Commence Co	N =4
Season Heating and Continue	
Economic Life: -= Yrs. Date Prepared 10/62 Prepared by	TUP
TESTS	
T. hon-recurring Initial Capital Costs:	10 133
a. CNI b. Design	2 645
c. Salva c	
d. Total BENEFITS:	22,778
Recurring Benefit/Cost Differential Other Than Energy:	A A W
a. Annual Labor Decrease (+)/increase (-)	$\frac{3-44}{9}\frac{1}{1}\frac{1}{1}$
b. Annual Material Decrease (+)/Increase (-)c. Other Annual Decrease (+)/Increase (-)	0 /11.
d. Total Costs	- 441 /Yr.
e. 10: Discount Factor f. Discounted Recurring Cost (d x e)	-2519
Feguring Energy Benefit/Costs:	•
a. Type of Fuel: Fig. Co.: (1) Annual Energy Decrease (*)/Increase(*)	273 P©TU
(1) Annual Energy Decrease (*)/increase(*) (2) Cost per MSTU	1/2 VA /RETU
(3) Annual Dollar Decrease/Increase ((1)x(2))	\$ 3.762 /Tr.
(4) Differential Escalation Rate (AS)Factor (5) Discounted Dollar Decrease/Increase(3)x(4)	\$ 47.53.7
b. Type of fuel: rienders du	
(1) Annual Energy Decrease (+)/Increase (+) (2) Cost per MBTU	24 MATU
(3) Annual Dollar Decrease/Increase ((1)X(2))	8 E / /Yr.
(4) Differential Escalation Rate (7 %) Factor	1093
<pre>(5) Discounted Dollar Decrease/Increase ((3)x(4)) c. Type of Fuel:</pre>	
. (1) Annual Energy Decrease (+)/Increase (-)	MBTU /MBTU
(2) Cost per MBTU (3) Annual Dollar Decrease/Increase ((1)x(2))	/۲۲.
(4) Differential Escalation Rate (%) Factor	
(5) Discounted Dollar Decrease/Increase ((3)x(4))	
d. Type of Fuel: (1) Annual Energy Decrease (+)/Increase (-)	METU
(2) Cost per MBTU	Matu Vr.
(3) Annual Dollar Decrease/Increase ((1)x(2)) (4) Differential Escalation Rate (%)Factor	•
(5) Discounted Dollar Decrease/Increase ((3)x(4))	
e. Discounted Energy Benefits (34(5)+35(5)+3c(5)+3d(5))	50 420 46 901
4. Total Benefits (Sur 21+3e) 5. Discounted Benefit/Cost Ratio (Line 4-Line 1d)	2,057
 Total Annual Energy Savings (3a(1)+3b(1)+3c(1)+3d(1)) 	302
7. E/C Ratio (Line 6 + Line la/1000) 8. Annual & Savings (2d+3a(3)+3b(3)+3c(3)+3d(3))	15,0 3 410
9. Pay-back Period ((Line la - Salvage)+Line 8)	5.904
10, wife cycle Level (Line did-24-36)	-4. £4,123

Location: Colorado Epringe Co	FY E4
Night Setlant in Labour	
Economic Life: 15 Vrs. Date Prepared 10/82 Prepared by	JLP
COSTS	
T. hon-recurring Initial Capital Costs: a. CAI 	5,7-66
b. Design c. Eculage	424
d. Total	<u> 2695</u>
BENIFITS: 2. Recurring Benefit/Cost Differential Other Than Energy:	
B. Annual Labor Decrease (*)/Increase (-)	\$ - 72 /Yr.
b. Annual Material Decrease (+)/Increase (-) c. Other Annual Decrease (+)/Increase (-)	S C /Yr.
d. Total Costs	-72 /YF.
 e. 10: Discount Factor f. Discounted Recurring Cost (d x e) 	7.950
3. Fecurring Energy Benefit/Costs:	
a. Type of Fuel: First Cil (1) Annual Energy Decrease (+)/Increase(-)	60 PETU
(2) Cost per MSTU	\$ 12.75 /METU
(3) Annual Dollar Decrease/Increase ((1)x(2)) (4) Differential Escalation Rate (£\$)Factor	\$ <u>527 /1r.</u> 15.112
(5) Discounted Dollar Decrease/Increase(3)x(4)	10,944
b. Type of Fuel: Electricity (1) Annual Energy Decrease (+)/Increase (-)	-// M BTU
(2) Cost per MBTU	S 3.67 /MBTU
(3) Annual Dollar Decrease/Increase ((1)X(2)) (4) Differential Escalation Rate (_7_5) Factor	12 3.7E
(5) Discounted Dollar Detrease/Increase ((3)x(4))	\$ - 417.
c. Type of Fuel: (1) Annual Energy Decrease (+)/Increase (-)	MSTU_
(2) Cost per MBTU	\$ /MBTU
(3) Annual Dollar Detrease/Increase ((1)x(2)) (4) Differential Escalation Rate (_3) Factor	\$Yr.
(5) Discounted Collar Decrease/Increase ((3)x(4))	
 d. Type of Fuel: (1) Annual Energy Decrease (+)/Increase (-) 	MBTU
(2) Cost per MBTU	/Hatu
 (3) Annual Dollar Decrease/Increase ((1)x(2)) (4) Differential Escalation Rate (5)Factor 	Yr.
(5) Discounted Dollar Decrease/Increase ((3)x(4))	
 Discounted Energy Benefits (3a(5)+3b(5)+3c(5)+3d(5)) Total Benefits (5um 2f+3e) 	10,427 9,852
5. Discounted Benefit/Cost Ratio (Line 4+Line 1d)	2.6.6
 Total Annual Energy Savings (3a(1)+3b(1)+3c(1)+3d(1)) E/C Ratio (Line 6 ÷ Line 1a/1000) 	15.0
8. Annual \$ Savings (2d+3a(3)+3b(3)+3c(3)+3d(3))	\$ 7.21
9. Pay-back Period ((Line ia - Salvage) Line B)	<u>4.53</u> -4 <u>6.151</u>
10. Life cycle cost (Line 1d-2f-3e)	-3

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Location: Coloned & Copenhage Co	M =1
Project: Aero Las	
Economic Life: 1- Yrs. Date Prepared 10/62 Prepared by	<u> </u>
10575	
7. Abn-recurring Initial Capital Costs: a. CNI	1 No 188
b. Design	2 4 2 4 <u></u>
c. Suitante	3
d. Total BENEFITS:	<u>54.567</u>
2. Recurring Benefit/Cost Differential Other Than Energy:	
a. Annual Labor Decrease (+)/Increase (-)	\$ - 572 /Yr.
b. Annual Material Decrease (+)/Increase (+)	5 /1r.
c. Other Annual Decrease (+)/Increase (-)d. Total Costs	5 - 572 /Yr.
e. 10: Discount Factor	7.950
f. Discounted Recurring Cost (d x e)	<u> - 2</u> 5 5 €
3. Fecurring Energy Benefit/Costs: a. Type of Fuel: Final model	
(1) Annual Energy Decrease (+)/increase(-)	396 PSTU
(2) Cost per M5TU	\$ /= . // = /MSTU
(3) Annual Dollar Detrease/Incres e ((1)x(2)) (4) Differential Excalation Rate (⇔ %)Factor	\$ E 4ET/YE.
(4) Differential Escalation Rate (会 S)Factor (5) Discounted Dollar Decrease/Increase(3)x(4)	12 112 7' 552
b. Type of Fuel: the order of the	
(1) Annual Energy Decrease (+)/Increase (-)	-4 Matu
(2) Cost per MBTU (3) Annual Dollar Decrease/Increase ((1)X(2))	-/2 /Yr.
(4) Differential Escalation Rate (- 3) Factor	2275
(5) Discounted Dollar Decrease/Increase ((3)x(4))	\$ -147:
c. Type of Fuel: (1) Annual Energy Decrease (+)/Increase (-)	METU
(2) Cost per M3TU	\$ /Hatu
(3) Annual Dollar Decrease/Increase ((1)x(2))	S /Yr.
(4) Differential Escalation Rate (
(5) Discounted Dollar Decrease/Increase ((3)x(4))d. Type of Fuel:	
(1) Annual Energy Decrease (+)/Increase (-)	METU
(2) Cost per MBTU	Maru_
 (3) Annual Dollar Decrease/Increase ((1)x(2)) (4) Differential Escalation Rate (_X)Factor 	\$
(5) Discounted Dollar Decrease/Increase ((3)x(4))	5
 Discounted Energy Benefits (34(5)+35(5)+3c(5)+3d(5)) 	71.405
4. Total Benefits (Sun Zf+3e)	Sec ed o
 Discounted Benefit/Cost Ratio (Line 4+Line 1d) Total Annual Energy Savings (3a(1)+3b(1)+3c(1)+3d(1)) 	<u> </u>
7. E/C Ratio (Line 6 + Line 1a/1000)	_/5.2
 Annual & Savings (2d+3a(3)+3b(3)+3c(3)+3d(3)) 	\$ 4.873
9. Pay-back Period ((Line la - Salvage) (Line B)	5.36
10. Life Cycle Cost (Line 1d-2f-3e)	- b <u>27,273</u>

Location: Colorado Spruge, Ci	N_ 64
Frojetti Aero Lah Evaporative Cooling	
Economic Life: Date Prepared 10/32 Prepared by	JUI D
TOSYS T. hon-recurring Initial Capital Costs:	
a. CNE	<u></u>
b. Design	
c. <u>Salvage</u> d. Total	
d. Total Binifits:	
2. Recurring Benefit/Cost Differential Other Than Energy:	A 10
a. Annual Labor Decrease (+)/Increase (+)	/Yr.
 b. Annual Material Decrease (+)/Increase (+) c. Other Annual Decrease (+)/Increase (+)) / Tr.
d. Total Costs	Yr.
e. 10: Discount Factor	574
f. Discounted Recurring Cost (d x e)	•
3. Recurring Energy Benefit/Costs: a. Type of Fuel: Fixel mail	
(1) Annual Energ. Decrease (*)/Increase(-)	- 2012 PETU
(2) Coxt per MSTU	Yr.
 (3) Annual Dollar Decrease/Increase ((1)x(2)) (4) Differential Escalation Rate (5 S)Factor 	30,055
(5) Discounted Dollar Decrease/Increase(3)x(4)	\$
b. Type of Fuel: Flooding and a	3.2 MOTH
(1) Annual Energy Decrease (+)/Increase (-)	32 M3TU \$ 5.07 /M3TU
(2) Cost per MBTU (3) Annual Dollar Decrease/Increase ((1)X(2))	· /vr.
(4) Differential Escalation Rate (7 %) Factor	15 349
(5) Discounted Dollar Decrease/Increase ((3)x(4))	5
c. Type of fuel:	MBTU
(1) Annual Energy Decrease (+)/Increase (-) (2) Cost per MSTU	\$ /HETU
(3) Annual Dollar Decrease/Increase ((1)x(2))	\$/Yr.
(4) Differential Escalation Rate (%) Factor	,
(5) Discounted Dollar Decrease/Increase ((3)x(4))	*
d. Type of Fuel: (1) Annual Energy Decrease (+)/Increase (-)	METU
(2) Cost per MBTU	\$ /MBTU
(3) Annual Dollar Dermase/Increase ((1)x(2))	Yr.
(4) Differential Escalation Rate (_%)Factor (5) Discounted Dollar Decrease/Increase ((3)x(4))	
Discounted Course Repetits (3e(5)+3b(5)+3c(5)+3d(5))	
e. Discounted Energy Benefits (3a(5)+3b(5)+3c(5)+3d(5)) 4. Total Benefits (5un 2f+3e)	\$
5. Discounted Benefit/Lost Mailo (Line Willing 10)	170
6. Total Annual Energy Savings (3a(1)+3b(1)+3c(1)+3d(1))	<u>- 17c</u>
7. E/C Ratio (Line 6 + Line la/1000) 8. Annual \$ Savings (2d+3a(3)+3b(3)+3c(3)+3d(3))	\$
O Pau-ka-k Parind (()ine la - Salvaneleline U)	
10. Life cycle cost (Line 1d-24-2e)	-s

ECTP ECCHOMIC ANALYSIS SUMMAPY

Location:otorowo of prof it for	N 64
Projett: 60-c Late	
Economic Life: 5 Trs. Date Prepared K / 57 Prepared by	TIP
CUSTS	
T. Non-recurring Initial Capital Costs: a. CkE	• 6:
b. Design	
c. Salvare	
d. Total	42 214
BENEFITS	
2. Recurring Benefit/Cost Differential Other Than Energy:	• 10-
 a. Annual Labor Decrease (+)/Increase (-) b. Annual Material Decrease (+)/Increase (-) 	/YP.
c. Other Annual Decrease (+)/Increase (-)	17.
d. Total Costs	\$ - = = = /Yr.
e. 10: Discount Factor	- 2250
f. Discounted Recurring Cost (d x e)	\$ <u>-6 6</u> 1
3. Fecurring Energy Benefit/Costs: a. Type of Fuel: Final City	
(1) Annual Energy Decrease (*)/Increase(-)	EE2 METU
(2) Cost per MSTU	\$ 12 1/E /METU
(3) Annual Dollar Decrease/Increase ((1)x(2))	5 66% Tr.
(4) Differential Escalation Rate (2.3) Factor	-12-112
(5) Discounted Dollar Decrease/Increase(3)x(4) b. Type of Fuel: machine the	110 76 2
(1) Annual Energy Decrease (+)/Increase (-)	az matu
(2) Cost per Mālu	S CO /METU
(3) Annual Dollar Decrease/Increase ((1)X(2))	\$ 60 /YF.
 (4) Differential Escalation Rate (3) Factor (5) Discounted Dollar Decrease/Increase ((3)x(4)) 	12000
c. Type of fuel:	
(1) Annual Energy Decrease (+)/Increase (-)	MBTU_
(2) Cost per MBTU	Matu
(3) Annual Dollar Decrease/Increase ((1)x(2))	\$ /Yr.
 (4) Differential Escalation Rate (_3) Factor (5) Discounted Bollar Decrease/Increase ((3)x(4)) 	•
d. Type of Fuel:	•
(1) Annual Energy Decrease (+)/Increase (-)	METU_
(2) Cost per MBTU	\$ /Matu
(3) Annual Dollar Decrease/Increase ((1)x(2))	\$
 (4) Differential Escalation Rate (_\$)Factor (5) Discounted Dollar Decrease/Increase ((3)x(4)) 	
 (5) Discounted Dollar Decrease/Increase ((3)x(4)) e. Discounted Energy Renefits (3a(5)+3b(5)+3c(5)+3d(5)) 	100 578
4. Total Benefits (Sur 2f+3e)	11 E91
5. Discounted Benefit/Cost Ratio (Line 4:Line 1d)	2.14.1
6. Total Annual Energy Savings (3a(1)+3b(1)+3c(1)+3d(1))	574 mbty
7. E/C Ratio (Linz 6 + Line la/1000) A Approx 5 Services (24-2)(2)-2-(2)-3-(2)-3-(3)	15.0
 Annual & Savings (2d+3a(3)+3b(3)+3c(3)+3d(3)) Pay-back Period ((Line la - Salvage)+Line B) 	<u>- 623</u> 7 - 5.60
to the part of the	- 4 5 <u>C 547</u>
10. Life Cycle Cost (Line 1d - 2f - 3r)	

Project: Aprilab	Light-mig I	M 34
Conomic Life: 25 Yrs.	Date Prepared 10/62. Prepared by	512
T. hon-recurring Initial a. CWE	Capital Costs;	1 was 200
b. Design c. <u>Salvage</u> d. Total		0 5:4
BENEFITS: 2. Recurring Benefit/Cost a. Annual Labor Decre	Differential Other Than Energy:	\$_= / 364 /Yr
b. Annual Material Decre c. Other Annual Decre d. Total Costs	crease (+)/Increase (-)	0 /Yr. 0 /Yr. 1 250 /Yr.
e. 101 Discount Facto f. Discounted Recurry 3. Recurring Energy Benef	ing Cost (d x e)	9,524
a. Type of Fuel:	c 1 0:1 Decrease (*)/increase(-)	1 2/2 IETU 1 2 7 2 /RETU
(3) Annual Dollar (4) Differential	r Decrease/Increase ((1)x(2)) Fscalation Rate (£ \$)Factor collar Decrease/Increase(3)x(4)	16 TO / / IT. 20.05(20.05(
b. Type of Fuel: El (1) Annual Energ (2) Cost per M3T	y Lecrease (+)/increase (-)	/47 MBTU 8 8,67 /MBTU
(4) Differential (5) Discounted D	r Decrease/Increase ((1)X(2)) Escalation Rate (<u>-7</u> %) Factor pllar Decrease/Increase ((3)x(4))	\$ 4 5 /\r. 15.049 8 5 4 0
c. Type of Fuel: (1) Annual Energ. (2) Cost per MST	y Decreese (+)/Increase (-)	MBTU MBTU
(4) Differential	r Decrease/Increase ((1)x(2)) Escalation Rate (%) Factor ollar Decrease/Increase ((3)x(4))	\$/\r.
d. Type of Fuel: (1) Annual Energ (2) Cost per MBT	y Decrease (*)/Increase (*)	METU MATU
(3) Annual Dolla (4) Differential	r Decrease/Increase ((1)x(2)) Escalation Rate (S)Factor ollar Detrease/Increase ((3)x(4))	Ar.
e. Discounted Energy 4. Total Benefits (Sun 2	Benefits $(3+(5)+3b(5)+3c(5)+3d(5))$	3.4.0.19 3.4.0.19 3.162
6. Total Annual Energy S. 7. E/C Ratio (Line 6 + L	uvings (3a(1)+3b(1)+3c(1)+3d(1)) ine 1a/1000)	1, 351 MB1 w
 9. Pay-back Period ((Line 	3a(3)+3b(3)+3c(3)+3d(3)) e 1a - Salvage)+Line B; (Line 1d - Zf - Ze)	<u>15.165</u> 5.47 - 3.21,595

Location: Colorado Sono and Co	N 54
Project: Acres had	
Economic Elle: 25 Yrs. Date Prepared 1/e > Prepared by	
COSTS	
T. hon-recurring Initial Capital Costs:	3 468
a. CKE b. Design	52.)
e. Salvana	4489
d. Total BENEFITS	V_Epoles 1
 Recurring Benefit/Cost Differential Other Than Energy: Annual Labor Decrease (+)/Increase (-) 	\$ -87 /Yr.
b. Annual Material Decrease (+)/Increase (+)	£ /YF.
c. Other Annual Decrease (+)/Increase (+)	0 /Yr. -87 /Yr.
d. Total Costs e. 101 Discount Factor	9,5.4
 f. Discounted Resurring Cost (d x e) Resurring Energy Benefit/Costs: 	- 879
A. Type of Fuel: Final City	-54 12 70
(1) Annual Energy Decrease (+)/Increase(+) (2) Cost per MSTU	\$ 13.78 /KSTU
(3) Annual Dollar Decrease/Increase ((1)×(2))	\$ -1.15A /Yr.
(4) Differential Escalation Rate (= S)Factor (5) Discounted Dollar Decrease/Increase(3)x(4)	8 - 23 2/A
b. Type of fuel: Electricity	5/5 MBTU
(2) Cost per MaTU	MBTU
(3) Annual Dollar Decrease/Increase ((1)X(2)) (4) Differential Escalation Rate (= 3) Factor	\$_1581 /Yr.
(5) Discounted Dollar Decrease/Increase ((3)x(4))	\$ 7.8 536
c. Type of fuel: (1) Annual Energy Decrease (+)/Increase (-)	MBTU_
(2) Cost per MBTU	/MBYU
(3) Annual Dollar Decrease/Increase ((1)x(2)) (4) Pifferential Escalation Rate (3) Factor	
(5) Discounted Dollar Decrease/Increase ((3)x(4))	
d. Type of Fuel: (1) Annual Energy Decrease (+)/Increase (-)	MBTU
(2) Cost per MBTU (3) Annual Dollar Decrease/Increase ((1)x(2))	/MBYU
(4) Differential Escalation Rate (B) Factor	
(5) Discounted Dollar Decrease/Increase ((3)x(4)) e. Discounted Energy Benefits (3a(5)+3b(5)+3c(5)+3d(5))	5.318
4. Total Benefits (Sur 27+30)	
 Discounted Benefit/Cost Ratio (Line 4-Line 1d) Total Annual Energy Savings (3e(1)+3b(1)+3c(1)+3d(1)) 	431 MB1 W
7. E/C Ratio (Line 6 + Line 1a/1000)	3 336
 Annual & Saviras (2d+3a(3)+3b(3)+3c(3)+3d(3)) Pay-back Period ((Line la - Salvape)+Line B) 	11. 8 yrs
10 Life-Cycle cood (Id-24- de)	-4

	Jest: Agre hab	N 50
Ecor	nomic Life: 25 yrs. Date Prepared 1/82 Prepared by	TIP
COST		
••	Non-recurring Initial Capital Costs: a. CWE	\$ 14.667
	b. Design	\$ 2.190
	e. Salvage	
BENI	d. Total	8.857
2.	Recurring Benefit/Cost Differential Other Than Energy:	
• •	a. Annual Labor Decrease (+)/Increase (-)	\$ -365 /\frac{1}{2}
	b. Annual Material Decrease (+)/Increase (-)	\$/Yr.
	C. Other Annual Decrease (+)/Increase (-)	O /Yr.
	d. Total Costs	-365 /Yr.
	f. Discount Factorf. Discounted Recurring Cost (d x e)	7.524
3.	Recurring Energy Benefit/Costs:	8 <u>-3,476</u>
	a. Type of Fuel: Fuel Cil	
	(1) Annual Energ. Decrease (+)/Increase(-)	196 PETU
	(2) Cost per MSTU	13.75 /MSTU
	(3) Annual Dollar Decrease/Increase ((1)x(2)) (4) Differential Escalation Rate (5 %)Factor	2.701 /1r.
	(5) Discounted Dollar Decrease/Increase(3)x(4)	\$ 54 155
	b. Type of fuel: property and a comment	
	(1) Annual Energy Decrease (+)/Increase (-)	54- MBTU
	(2) Cost per MBTU (3) Annual Dollar Decrease/Increase ((1)x(2))	3 - 7 /MBTU
	 (3) Annual Dollar Decrease/Increase ((1)X(2)) (4) Differential Escalation Rate (- 5) Factor 	146 /Tr.
	(5) Discounted Dollar Decrease/Increase ((3)x(4))	\$ 2,996
	C. Type of Fuel:	,
	(1) Annual Energy Decrease (+)/Increase (+)	MBTU
	(2) Cost per MBTU(3) Annual Dollar Decrease/Increase ((1)x(2))	/MATU
	(4) Differential Escalation Rate (8) Factor	
	(5) Discounted Dollar Decrease/Increase ((3)x(4))	8
	d. Type of Fuel:	
	(1) Annual Energy Decrease (+)/Increase (-)	MBTU
	(2) Cost per MBTU(3) Annual Dollar Decrease/Increase ((1)x(2))	/MBYU
	(4) Differential Escalation Rate (B)Factor	
	(5) Discounted Dollar Decrease/Increase ((3)x(4))	
_	 Discounted Energy Benefits (3a(5)+3b(5)+3c(5)+3d(5)) 	57.151
	Total Benefits (Sun 2f+3e)	\$ 55,675
5.	Discounted Benefit/Cost Ratio (Line 4+Line 1d) Total Annual Energy Savings (3a(1)+3b(1)+3c(1)+3d(1))	2,846
6. 7.	E/C Ratio (Line 6 + Line la/1000)	15.2
Í.	Annual & Savings (2d+3a(3) 3b(3)+3c(3)+3d(3))	2.502
J.	Pay-back Period ((Line la - Salvage) (Line B)	G.G. yrs
10	Life-cycle Court (1d-2f-3e)	3 - 14 + P/A

FORTH A-I

Location: Colorade Epringe CC	FY_ =2
Sunspace for Test Cell Classrooms	
Economic'Life: 25 Yrs. Date Prepared 1/63 Prepared by	JLD
TUSTS	
1. hon-recurring Initial Capital Costs:	_
8. Ch!	3333
b. Design c. <u>Salono</u> e	438
d. Total	
BENEFITS	₹
2. Recurring Benefit/Cost Differential Other Than Energy:	
a. Annual Labor Defrease (+)/Increase (-)	\$ - 73 /Yr.
b. Annual Material Decrease (+)/Increase (-)	Ç Yr.
<pre>C. Other Annual Decrease (+)/Increase (-) d. Total Costs</pre>	\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\
e. 10: Discount Factor	S S A
f. Discounted Recurring Cost (d x e)	\$ - 645
3. Recurring Energy Benefit/Costs:	
a. Type of Fuel Fuel Oil	
<pre>(1) Annual Energ. Decrease (+)/Increase(-) (2) Cost per MSTU</pre>	46 PETU \$ 13,75 /KSTU
(3) Annual Dollar Decrease/Increase ((1)x(2))	12,7 = /K3TU 6:4 /Yr.
(4) Differential Escalation Rate (20.050
(5) Discounted Dollar Decrease/Increase(3)x(4)	\$ 12.712
b. Type of Fuel:	AMPII
(1) Annual Energy Decrease (+)/Increase (-)(2) Cost per MaTU	4 MBTU 3,07 /MBTU
(3) Annual Dollar Decrease/Increase ((1)x(2))	3,07 /HBTU
(4) Differential Escalation Rate (\$) Factor	18.049
(5) Discounted Dollar Decrease/Increase ((3)x(4))	\$ 217
C. Type of Fuel:	MA DA
(1) Annual Energy Decretse (+)/Increase (-) (2) Cost per MBTU	MBTU /HBTU
(3) Annual Dollar Decrease/Increase ((1)x(2))	\$ /Yr.
(4) Differential Escalation Rate (5) Factor	
(5) Discounted Dollar Decrease/Increase ((3)x(4))	\$
d. Type of Fuel:	
(1) Annual Energy Decrease (+)/Increase (-) (2) Cost per MBTU	S PRITU
	/\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\
(3) Annual Dollar Decrease/Increase ((1)x(2)) (4) Differential Escalation Rate (_S)Factor	
(5) Discounted Dollar Decrease/Increase ((3)x(4))	
 Discounted [nergy Benefits (3x(5)+3b(5)+3c(5)+3d(5)) 	12.939
4. Total Benefits (Similar+Je)	\$ 12.2.34
- C - Diagnum 4 a 4 - Basadii 4 / Pana - Basai	
5. Discounted Benefit/Cost Ratio (Line 4-Line 1d) 6. Total Appual Energy Savinos (2-(1)-2	3,344
 Total Annual Energy Savings (3a(1)+3b(1)+3c(1)+3d(1)) 	50 KBtu
7. E/C Ratio (Line 6 + Line la/1000)	50 KBtu
7. E/C Ratio (Line 6 + Line la/1000)	50 KBtu

Project: Less Lab	prings co	N EL
Economic Life: weres.	Date Prepared 1/02 Prepared by	Л.
COSTS		
i. Non-recurring Initial C a. CWE	apital Losts:	\$ 65,205
b. Design		E 5%
c. Salvana		
d. Total		72 766
BENEFITS		<u> </u>
2. Recurring Benefit/Cost	Differential Other Than Energy:	
a. Annual Labor Decrea	se (+)/Increase (-)	<u>-1427 /YF.</u>
 b. Annual Material Dec 		C /YF.
c. Other Annual Decrea	se (+)/Increase (-)	C /Yr.
d. Total Costs		-: 42 T YF.
e. 10: Discount Factor		4,426
f. Discounted Recurring		-
3. Recurring Energy Benefi a. Type of Fuel: Fig.	- (C .)	
(1) Appual Frage.	Decrease (+)/increase(-)	1 632 MTU
(2) Cost per Maiu	perianse (-)/ meranse(-)	\$ 3.72 /KSTU
	Decrease/Increase ((1)x(2))	\$ 14 221 /YF.
(4) Differential E	scalation Rate (£ \$)Factor	
(5) Discounted Dol	lar Decrease/Increase(3)x(4)	16/38-1
b. Type of fuel: Elec	H-141+4	
(1) Annual Energy	Decrease (+)/increase (-)	<u>-54 MBTU</u>
(2) Cost per MBTU		S e cri /MBTU
	Decrease/Increase ((1)X(2))	\$ -166 /Tr.
(4) Differential E	scalation Rate (16.044
	lar Decrease/Increase ((3)x(4))	-2496
c. Type of Fuel:	Additional Control of the Control of	When
	Deurecse (+)/Increase (-)	S MBTU /HBTU
(2) Cost per MBTU (3) Annual Dollar	Decrease/Increase ((1)x(2))	/\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\
	scalation Rate (_S) Factor	•
(5) Discounted Dol	lar Decrease/Increase ((3)x(4))	2
d. Type of Fuel:	110 Sections (10/2/7/	·
()) Annual Energy	Decrease (+)//ncrease (-)	MBTU_
(2) Cost per MBTU		\$ 7HBYU
(3) Annual Dollar	Decrease/Increase ((1)x(2))	\$ /Yr.
(4) Differential E	scalation Rate (_S)Factor	
(5) Discounted Dol	lar Docrease/Increase ((3)x(4))	
e. Discounted Energy B	lenefits (3a(5)+3b(5)+3c(5)+3d(5))	222/35
4. Total Banefits (50% 2f+	31)	\$ in \$ 514
5. Discounted Benefit/Cost	Ratio (Line 4-Line 1d)	2.640
6. Total Annual Energy Sav	/ings (3a(1)+3b(1)+3c(1)+3d(1))	47Emble
7. E/C Ratio (Line 6 + Lin		15:0
8. Annual & Savings (2d+3a		\$ <u></u>
9. Pay-back Period ((Line		<u> </u>
اه ، ساخه - دیره او تمیمل (۱	Line 11 21. 21)	-s <u>194,27</u> 8
	•	•

cation: Calabada Continge Co	N 56
onomic Life: 2 - Yrs. Date Prepared 1/82 Prepared b	y II.
	7
hon-recurring Initial Capital Costs:	
a. CKS	\$ 1.785
b. Design	2.2.5
C. Salance	
d. Total	12,021
NIFITS: Recurring Benefit/Cost Differential Other Than Energy:	,
a. Annual Labor Decrease (+)/Increase (-)	\$ - 20 /Yr.
b. Annual Material Decrease (+)/Increase (-)	S C /Yr.
c. Other Annual Decrease (+)/Increase (-)	O /Ir.
d. Total Costi	- 28 /Yr.
e. 10: Discount Factor	9.524
f. Discounted Recurring Cost (d x e) Recurring Energy Benefit/Costs:	-36
a. Type of Fuel: Fig. 1	
(1) Annual Energy Decrease (*)/Increase(*)	⊃ P©TU
(2) Cost per M5TU	\$ / /K5YU
(3) Annual Dollar Decrease/Increase ((1)x(2))	\$
(4) Differential Escalation Rate (28)Factor (5) Discounted Dollar Decrease/Increase(3)x(4)	
b. Type of Fuel: Fig. 4	•
(1) Annual Energy 1-crease (*)/Increase (-)	4.3 MBTU
(2) Cost per MBTU	METU
(3) Annual Dollar Decrease/Increase ((1)X(2))	\$ 132 /Yr.
(4) Differential Escalation Rate (- 3) Factor (5) Discounted Dollar Decrease/Increase ((3)x(4))	<u> </u>
(5) Discounted Dollar Decrease/Increase ((3)x(4)) c. Type of Fuel:	2, 302
(1) Annual Energy Decrease (+)/Increase (-)	MBTU
(2) Cost per MBTU	\$ /MBTU
(3) Annual Dollar Decrease/Increase ((1)x(2))	\$
(4) Differential Escalation Rate (3) Factor	•
(5) Discounted Dollar Decrease/Increase ((3)x(4)) d. Type of Fuel:	•
(1) Annual Energy Decrease (+)/Increase (-)	MBTU
(2) Cost per MBTU	\$ /MBYU
(3) Annual Dollar Decrease/Increase ((1)x(2))	Yr.
(4) Differential Escalation Rate (8) Factor	
(5) Discounted Dollar Decrease/Increase ((3)x(4))	\
e. Discounted Energy Benefits (3a(5)+3b(5)+3c(5)+3d(5); Total Benefits (Sun 2f+3e)	2.382 2.021
Discounted Benefit/Cost Ratio (Line 4+Line ld)	
Total Annual Energy Savings (3a(1)+3b(1)+3c(1)+3d(1))	<u> 42018</u>
E/C Ratio (Line 6 + Line la/1000)	24.1
Annual & Savings (2d+3a(3)+3b(3)+3c(3)+3d(3))	\$_ <u>#</u> _\$_
Pay-back Period ((Line la - Salvage) (Line 3)	
. wide - cycle cout (with ad-21-30)	- h <u>Q</u>